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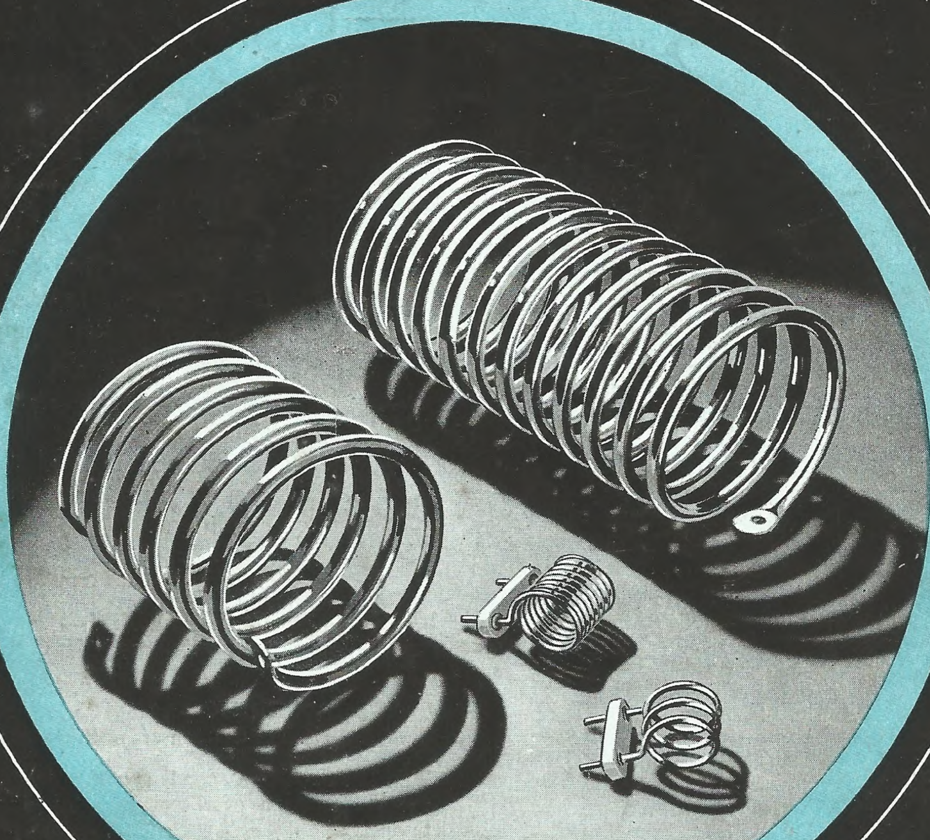

MAY 1942

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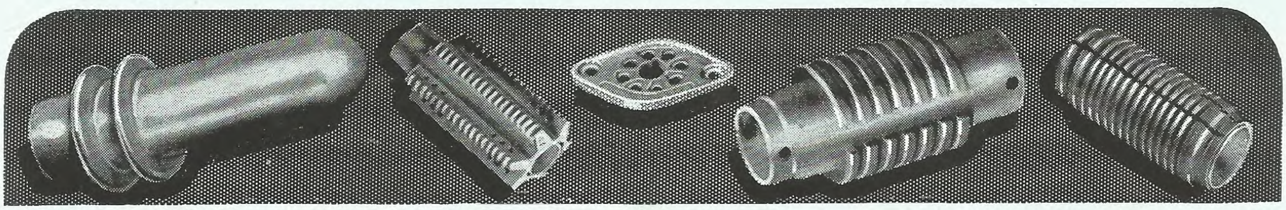
Vol. XLVIII No. 5

F-M *VERSUS* HOMODYNE ◈ NEW D-C AMPLIFIER



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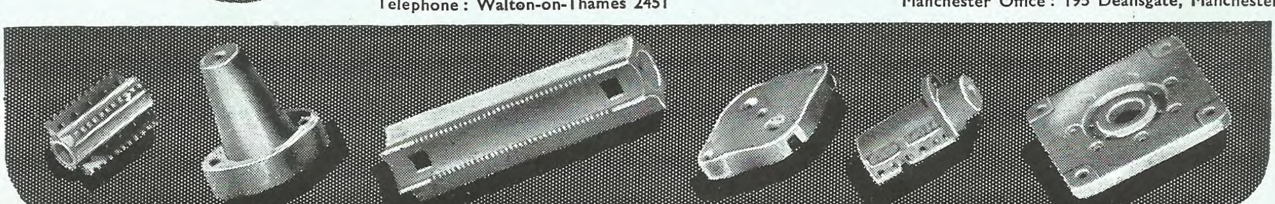

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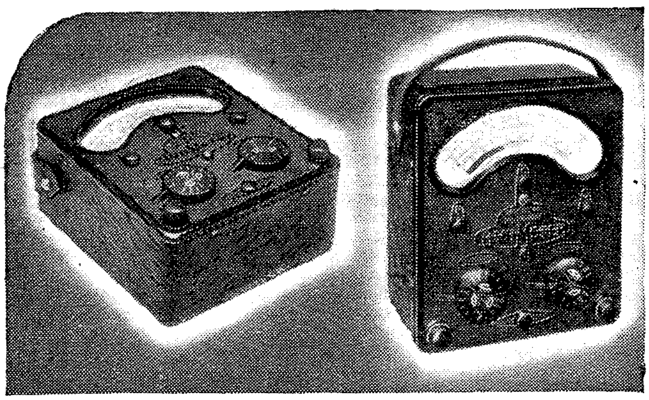
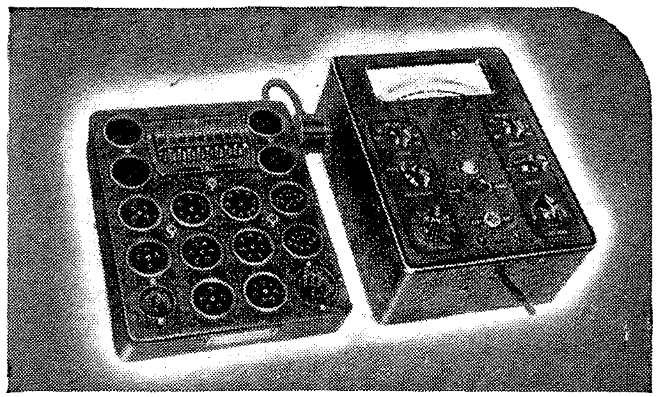
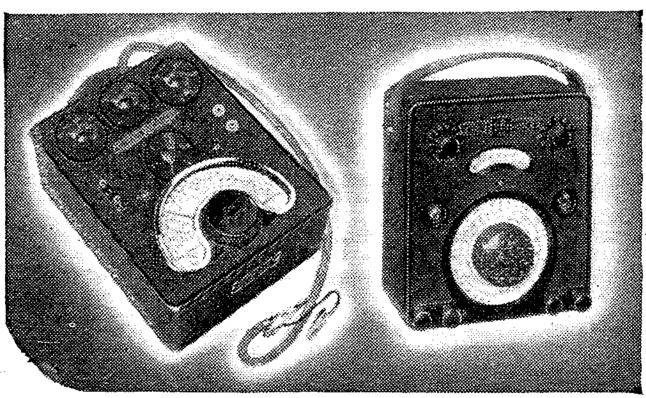


"Avo" Valve Tester with Universal Panel





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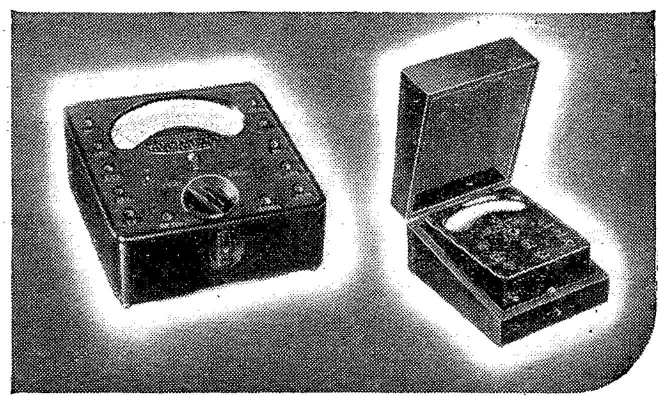

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Write for literature fully descriptive of any "Avo" Instrument in which you are interested.

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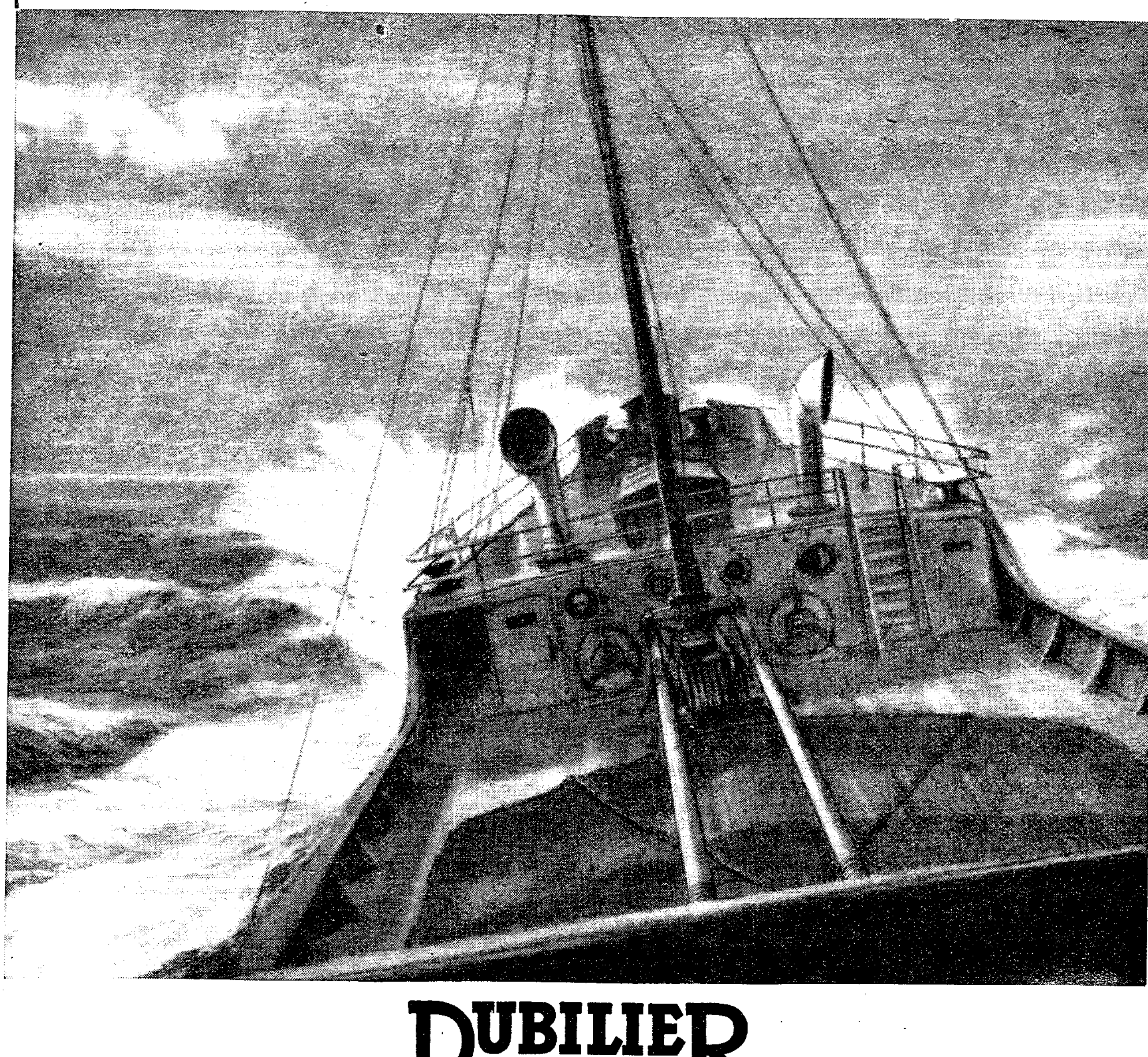

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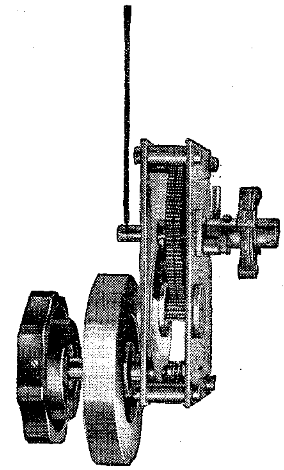
Bandspread superseded

Amongst the many special features of the Eddystone "358" Communication Receiver the main tuning control is of special interest. Bandspread is superseded by a logging scale, the readings on which are amplified by a secondary vernier dial. This system gives all the advantages of bandspread, whilst making a return to any given position simple, as the main dial remains accurately calibrated. The fly wheel drive described alongside adds considerably to simplicity of control. These are but two of the many refinements indicative of the care and precision which Eddystone engineers have expended on both the "358" and its counterpart the Medium Frequency Model "400."

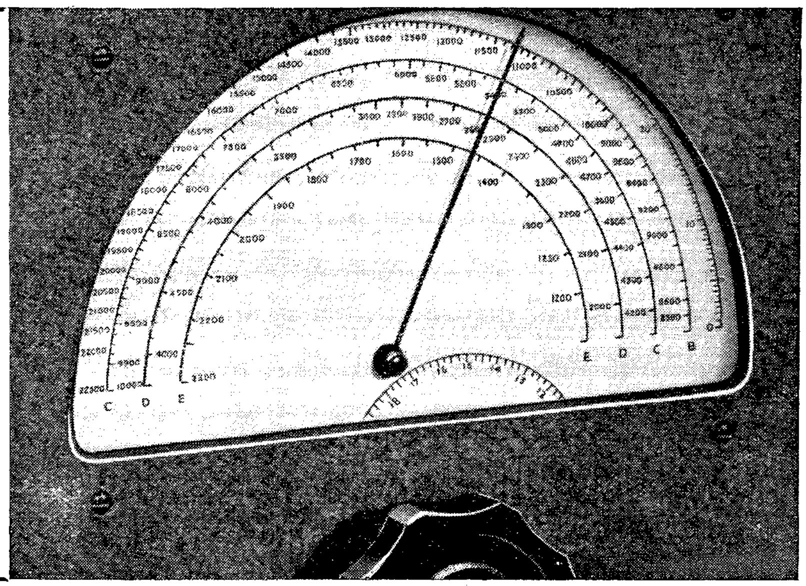
MAIN TUNING CONTROL

What is, in effect, mechanical Bandspread, is supplied by the fly wheel control and spring loaded Tufnol Gearing fitted to the main tuning control. Its mechanism is illustrated alongside. The gearing gives a ratio of 70-1 and makes possible minutely accurate logging. The progression of the pointer across the dial can be controlled to give hardly perceptible movement, and the action of the whole component is unbelievably smooth.



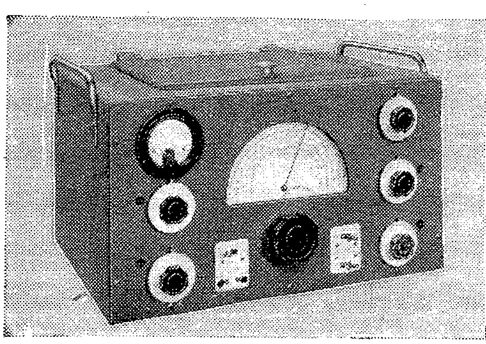
EDDYSTONE

"358"



EDDYSTONE "358" COMMUNICATION RECEIVER. *Specification :* The receiver employs one stage of R.F. amplification, frequency changer, two I.F. amplifiers, a separate beat frequency oscillator, octal base Mullard or Osram 6.3 volt valves. Frequency range is continuous from 22 M/cs. to 1.25 M/cs. using four fully screened interchangeable coil units. Five additional coil units extend the range to 31 M/cs. and 90 K/cs. Illuminated dial is accurately calibrated with four standard coils. Additional coils supplied with separate graph. To simplify maintenance a meter and test switch is fitted. Main tuning control incorporates fly wheel drive and spring loaded Tufnol gearing (ratio 70-1). Logging scale supersedes the old type bandspread control. Separate power unit assures freedom from drift.

MEDIUM FREQUENCY MODEL "400." A highly sensitive receiver covering medium frequencies only. Similar to the "358" but is provided with four coils only covering frequency range from 130 K/cs. to 2,200 K/cs. Optimum gain is secured with very high signal to noise ratio.



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Special Models of the Eddystone "358" and "400" are available with Band-pass Crystal Filters.

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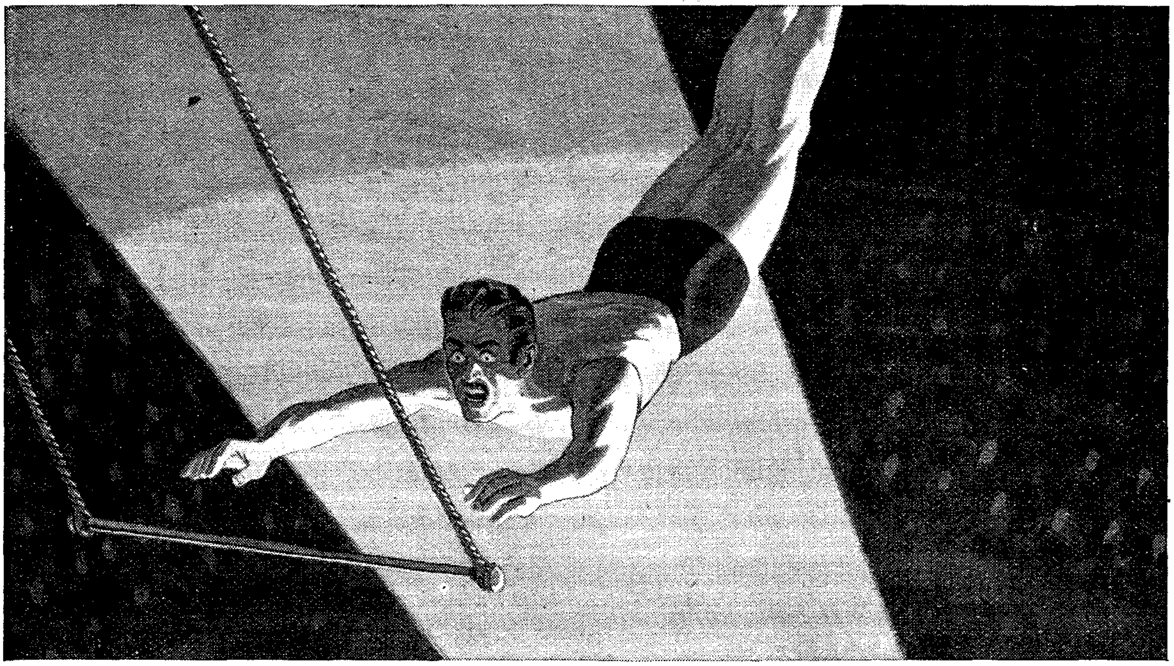

The abyss of nearly

THE trapeze artiste is an aristocrat in the profession. To avoid "missing it" his life has been an intensive specialization.

When the wheels of industry must run fast less time is available for analysis, for thought, for experimentation. The chances of "missing it" are thus perilously magnified. It is therefore natural that industry to-day in ever widening fields is relying upon the Simmonds Organization for the development and supply of products bred of the successful resolution of specific problems.

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P.4

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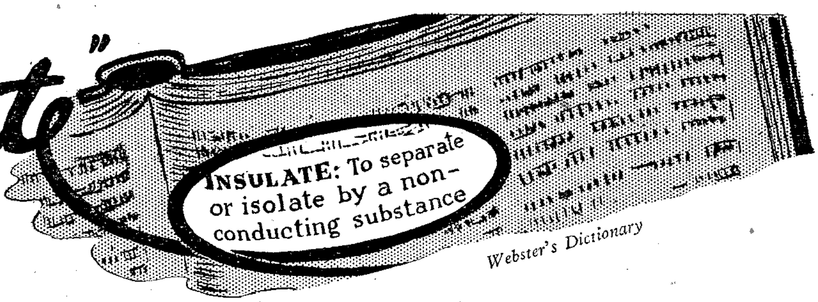

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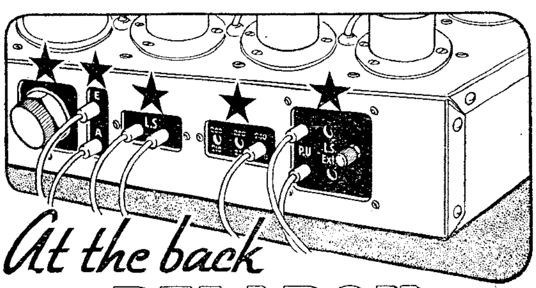

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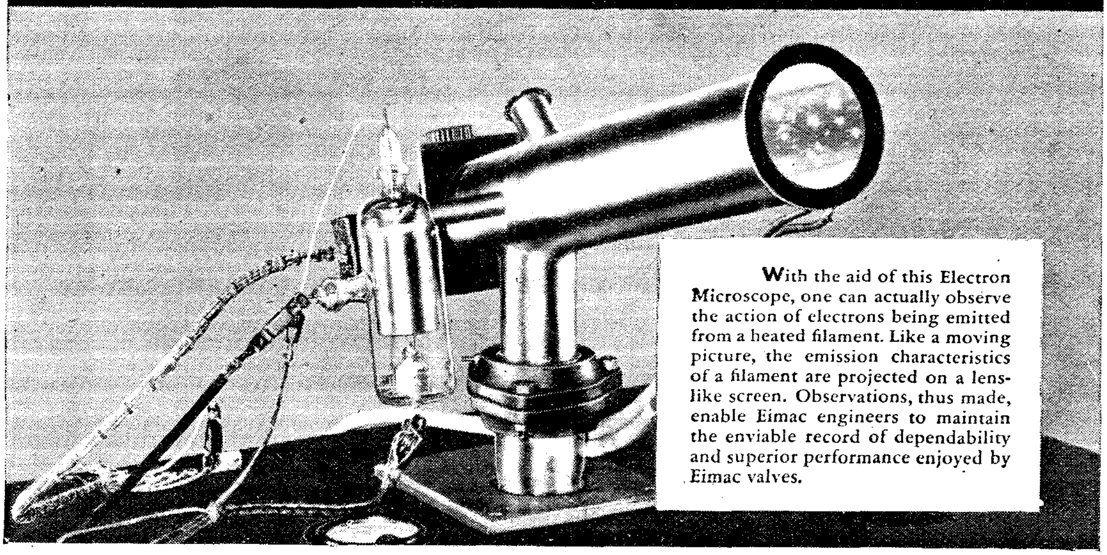
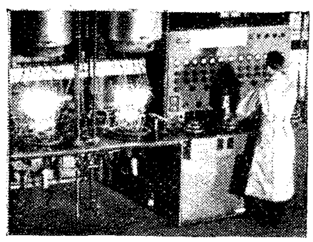
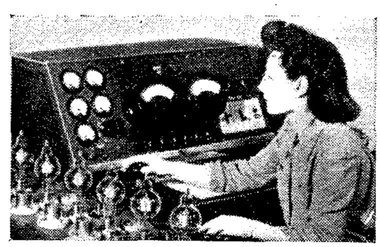


With the aid of this Electron Microscope, one can actually observe the action of electrons being emitted from a heated filament. Like a moving picture, the emission characteristics of a filament are projected on a lens-like screen. Observations, thus made, enable Eimac engineers to maintain the enviable record of dependability and superior performance enjoyed by Eimac valves.

Before filament assemblies are sealed into the valves they are placed under a temporary vacuum and heated to much higher temperatures than normal. This vital test enables technicians to weed out faulty parts before valve is actually pumped.



Hard vacuum is essential to preserve peak filament emission. Special pumps are built in the Eimac laboratories to fit the exact requirements of Eimac valves. During the pumping process, plate dissipation is run up to ten times normal. Valves that cannot stand this abuse never leave the factory



Here is a special Emission Tester which enables laboratory men to ascertain the actual performance capabilities of filaments after the valves are completed. Under this test filaments are made to perform much more difficult tasks than could possibly be required under normal operating conditions.

MAXIMUM FILAMENT EMISSION ASSURED IN EIMAC VALVES

All Eimac valves are unconditionally guaranteed against valve failures resulting from gas released internally. No other valve carries such a guarantee. This guarantee plus the fact that leading engineers throughout the world use and recommend them provides ample reasons for you to consider Eimac valves for your application.

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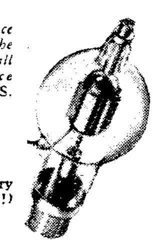
Eimac's unusual performance capabilities are receiving the enthusiastic acceptance in all branches of the service ARMY, NAVY, AIR CORPS.



EIMAC 450T

(In use by practically every major airline in the U. S. A.!)

Filament Voltage	7.5 to 7.7 Volts
Filament Current (approx.)	12 Amperes
Maximum Plate Voltage	6000 Volts
Continuous Plate Dissipation	450 Watts
Power output at 75% efficiency	1350 Watts

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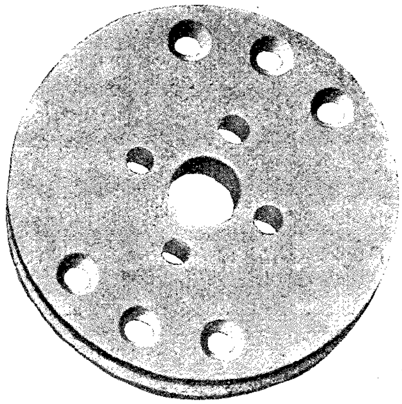

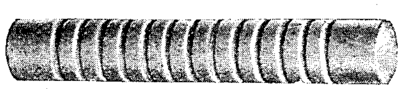

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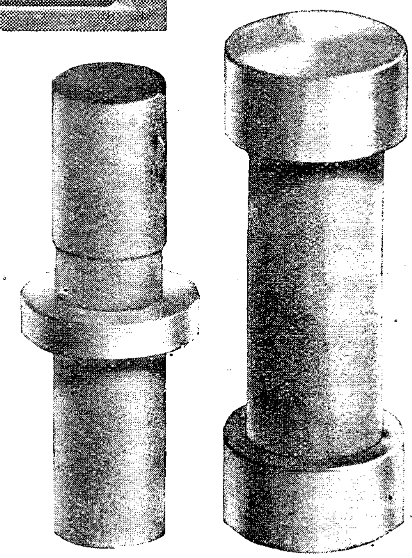

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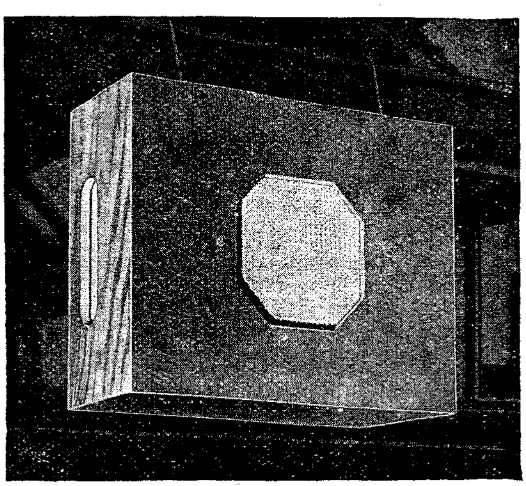

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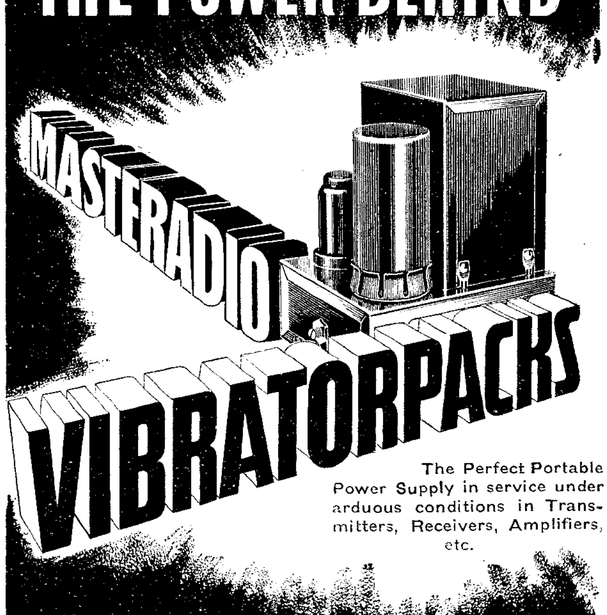

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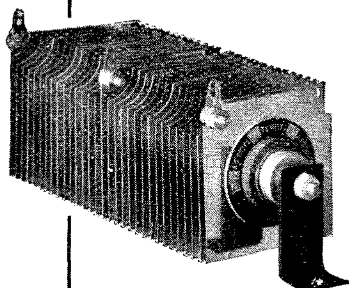

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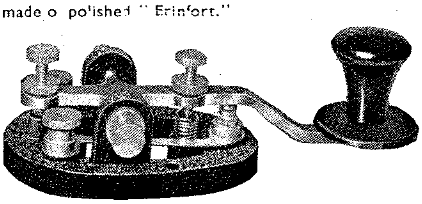

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Specification: The contacts are of ¼-in. solid sterling silver. A high grade of spring is fitted and gap adjustment is easily and accurately carried out. The base of the key is drilled for two-hole screw fixing. The appearance of the instrument is all that can be desired, and the metal parts are instrument lacquer finished.

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You will have no difficulty in aligning your instrument because the "Erinfort" cover for the wood base is all ready drilled and acts as a template.

THE KIT **7/6** *(Post free.)*

THE KIT OF PARTS INCLUDES:—

Solid brass bar ½-in. by 5/16-in. Set of pivot bushes for above. Pair of solid sterling silver contacts fitted to brass contact screws. Brass screw with knurled adjusting collar for varying tension on spring. Spring for above. Brass stop screw with knurled locking collar. Bakelite knob, heavy and highly polished, fitted with fixing screw. Washer or paddle for fitting below knob. Combined template and "Erinfort" base which covers the wood base.

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SLIDING RHEOSTATS (100-watts capacity). Fully enclosed, with bushed cable entry and laminated contacts, 10 ohms 3 amps., 100 ohms 1 amp., or 200 ohms 0.7 amp., any one, **18/6.** Also a few S.H. Isenthal, open type, 2.2 ohms 5 amps., **8/6.**

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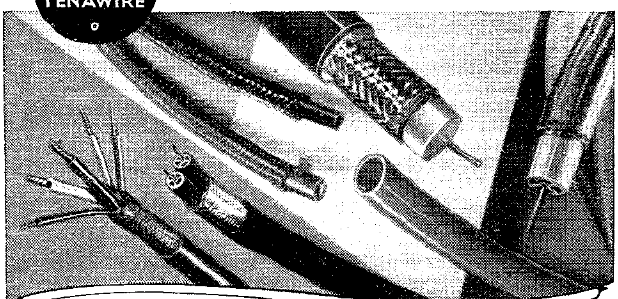

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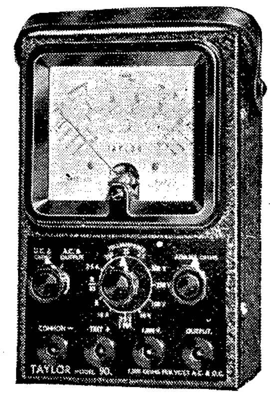

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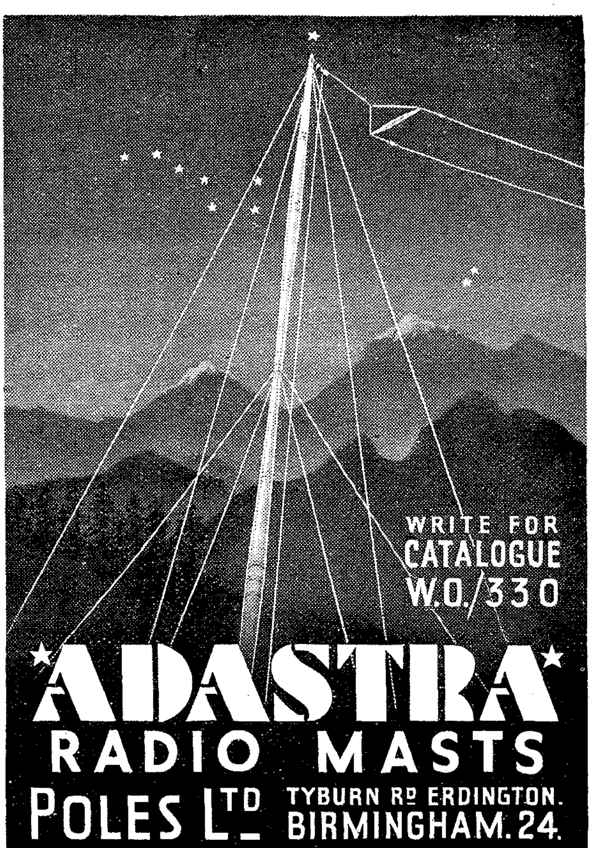

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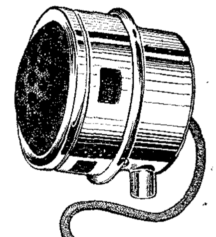

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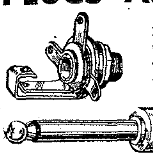

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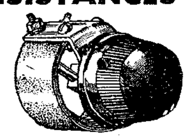

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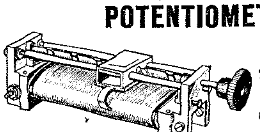

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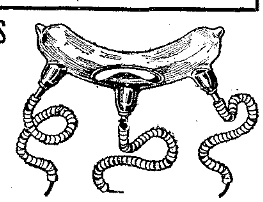

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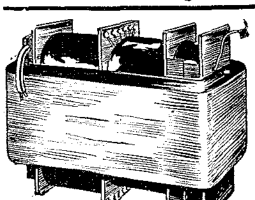

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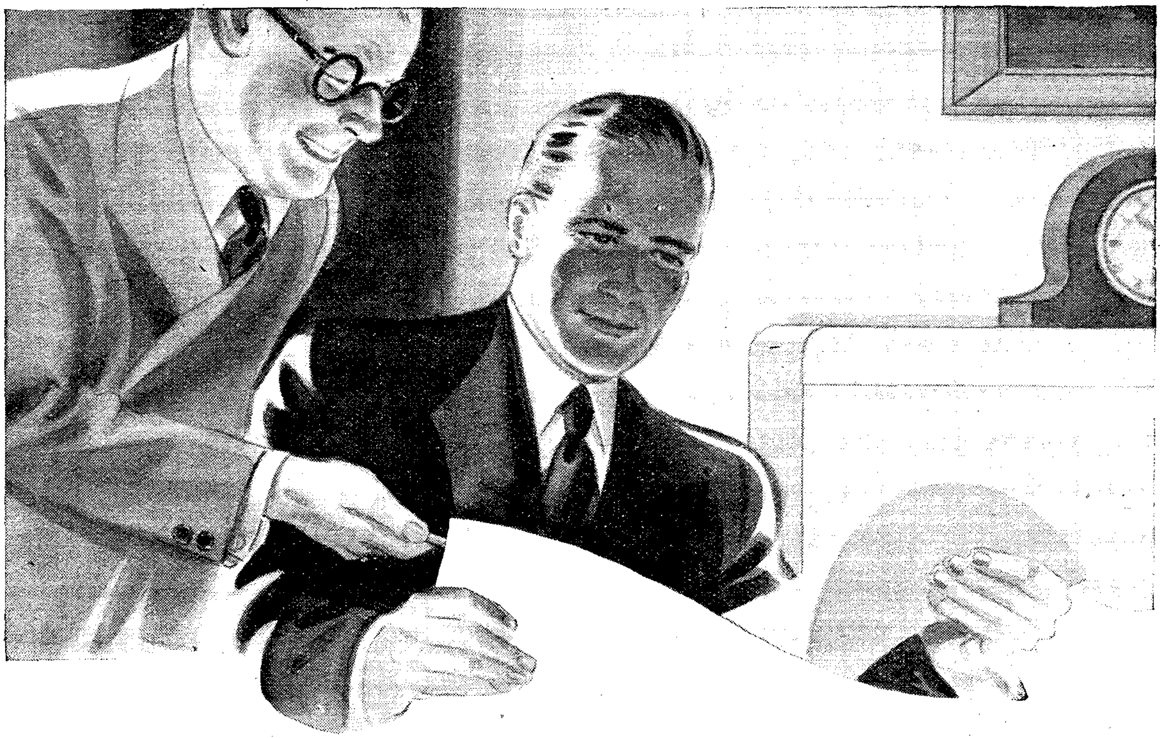

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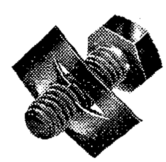

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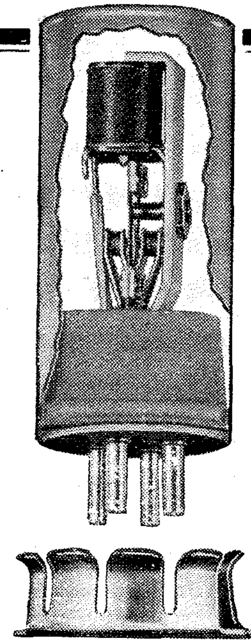

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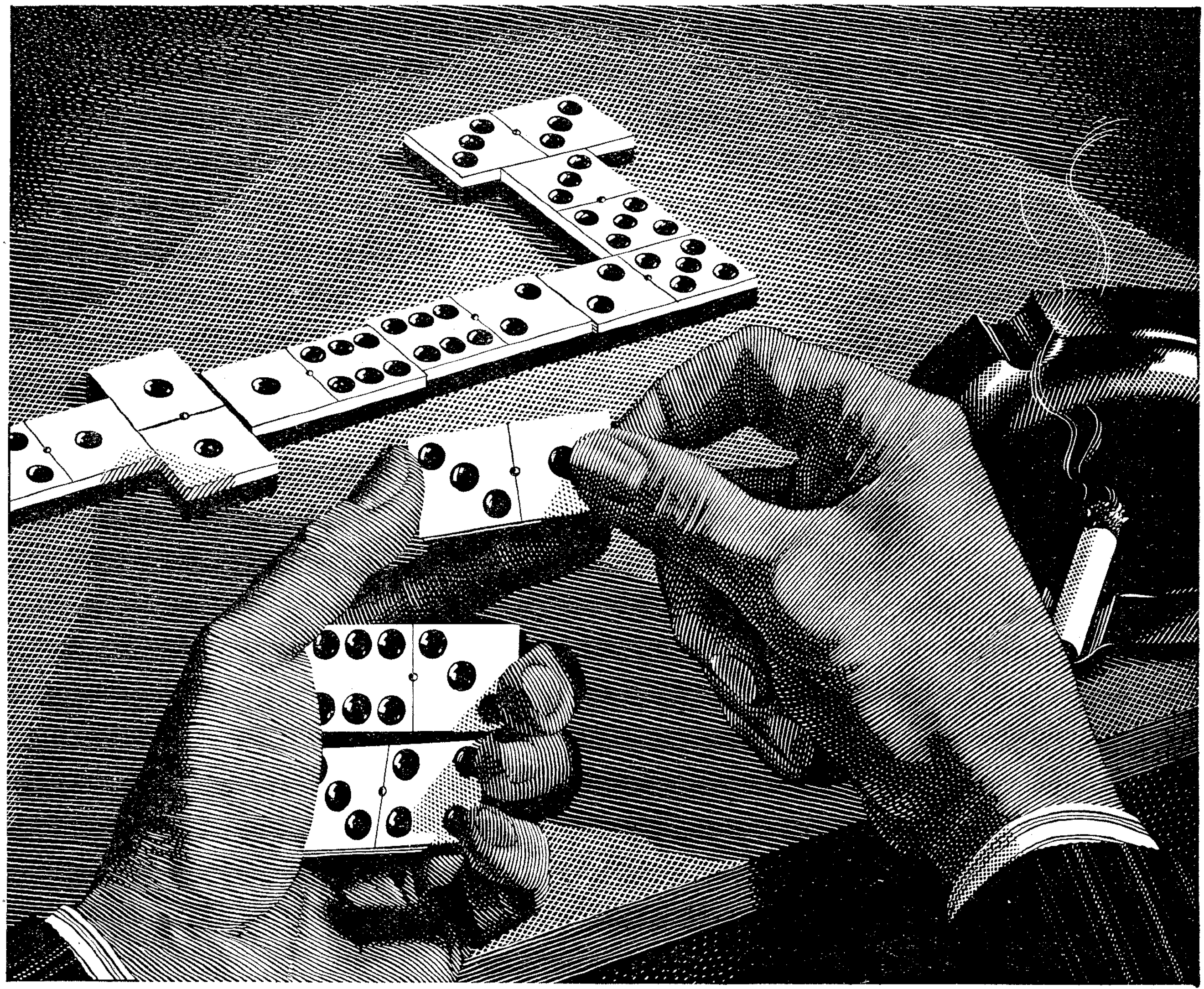

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Wireless World

Radio ◉ Electronics ◉ Electro-Acoustics

Vol. XLVIII. No. 5 | MAY 1942 | Price One Shilling

Inter-Allied Broadcast Schedules

Need for Wider Publicity

WE recently touched upon the changes that the international broadcasting position has undergone since the war became almost world-wide. It was pointed out that the need for convincing neutrals of the justice of our cause has almost disappeared, and that one of the main objects now is to cement friendship between the United Nations; to explain our various points of view to each other, and, above all, to pave the way for a real New World Order after the war.

However well international broadcasting may be conducted, it will obviously fail to achieve its object unless it can secure a large enough audience. Some of the obstacles—technical and otherwise—that stand in the way have already been discussed in our pages, and in many cases it has been possible to make suggestions for overcoming them.

There is one serious obstacle to the success of inter-allied broadcasting to which very little attention has been paid. Hardly any publicity is given to the times and frequencies of the transmissions, and, indeed, it is extremely difficult to obtain accurate information on this matter. Even from the Embassies in London of the various United Nations it is often impossible to obtain answers to the simplest questions on times of transmissions of talks in English from the countries concerned. If it is worth while broadcasting such talks, it is surely worth while taking elementary steps to see that they are heard as widely as possible in the country to which they are addressed.

Help from the Press

In this matter broadcasting is in need of the collaboration of the Press, and it is submitted that, in spite of the paper shortage, space might be found daily, with benefit to all concerned, for a few lines of information on broadcasts in English from all the United Nations.

Failing this, the Ministry of Information might include the information in its announcements broadcast through the B.B.C. Indeed, the co-operation of the B.B.C. in this matter would be invaluable, as, through its monitoring service, the Corporation is probably in a better position than anyone else to give accurate information as to times and frequencies of the transmissions. From our own observation, the Corporation in the conduct of its own Oversea Service sets a shining example to all the other Allied broadcasting authorities in making known the details of its many transmissions. Not only is a fairly large proportion of programme time devoted to announcing details of future transmissions; a great deal of printed matter is distributed through the post.

Confusion over Time

The announcement of transmission times and frequencies through the microphone can hardly be overdone. It is not enough, as so many stations do, merely to announce the time of the next programme.

When a broadcast is addressed to a single country, the times given should be according to the standard time adopted in that country. Great confusion arises through the incidence of daylight saving time, and this has been specially noticeable since BDST came into force. We imagine that few British listeners are capable of converting American "Eastern War Time" (in which most U.S. overseas programmes seem to be announced) into "British Double Summer Time."

Unless attention is paid to these matters, broadcasting cannot make its maximum contribution to the war effort. We have already pleaded that the problems of international broadcasting should be discussed on the broadest inter-allied basis; is it too much to suggest that a Board of Control, representative of all the United Nations, should be constituted to take care of these matters?

F-M OR HOMODYNE?

Advantages and Limitations of the Systems

By

D. A. BELL, M.A., B.Sc.

F-M (Frequency Modulation) has already passed from the experimental stage to commercial broadcasting in U.S.A., and is generally regarded as a step forward in radio technique. Meanwhile the homodyne type of receiver has been mentioned in this country as a promising type of receiver which has not yet been seriously developed; this article sets out the advantages and limitations of both F-M and homodyne, and shows that they are complementary rather than alternative systems

THERE are two outstanding technical problems in radio to-day; the improvement of the ratio of signal to interference (where "interference" includes both noise of all kinds and signals from unwanted stations) and the provision of increasing numbers of channels of communication; other problems are not so much technical as economic. For example, the question of "high fidelity" reduces to one of cost if interference is eliminated, and sensitivity is limited only by the internal noise-level of the receiver and the external interference level at the receiving aerial. Likewise, stereoscopic reception and colour television are technically easy; but require additional communication channels as well as a greater financial expenditure. It is very largely the demand for an ever-increasing number of channels of communication that has provided the initial incentive to raise the maximum carrier frequency in commercial use from that of the long-wave telegraph stations (of which Rugby GBR on 80 kc/s is a surviving example) to the centimetre-wave telephony services used by the Post Office for short sea crossings. (Admittedly the higher frequencies may require less power and be useful for directional working, but these were advantages discovered after their use had been forced on amateurs and others, rather than reasons for using them in the first place) All the subsidiary problems of ultra-high-frequency equipment, such as the design of suitable valves, can then be classed as part of the problem of finding more channels.

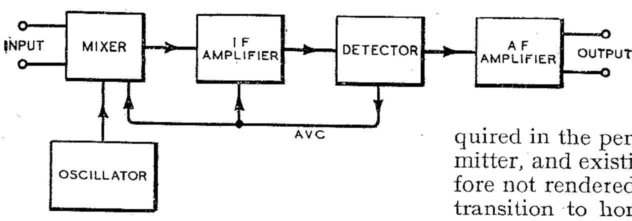


Fig. 1. Block diagram of a conventional superheterodyne broadcast receiver.

Turning then to the problem of signal/interference ratio, there are two lines of progress visible at the moment: homodyne reception and frequency-modulated communication. To give an idea of the changes involved in the receivers, Figs. 1, 2 and 3 give block diagrams of a conventional superheterodyne, homodyne, and FM receiver respectively. The homodyne receiver can be used on ordinary transmissions, simply as an alternative to the more usual type of receiver, and this is an important advantage; no change is required in the performance of the transmitter, and existing receivers are therefore not rendered unusable, so that the transition to homodyne reception can be gradual. But the benefits obtained from the adoption of homodyne receivers is strictly limited. Since it does not reduce heterodyne interference, but only modulated interference, it does not increase the audio band-width obtainable at a given spacing of adjacent carrier frequencies. Neither does it reduce noise of any kind. It has two advantages:—

(a) It reduces modulated interference.

(b) It simplifies the design of a distortionless detector, since the depth of modulation is always small.

But it was pointed out in the April *Wireless World* that the design becomes more difficult as the carrier frequency is raised, owing to the frequency stability required to enable the carrier to be reinforced without affecting the sidebands of low audio-frequency. From this one would judge that a homodyne receiver could be built for the medium-wave band, and possibly for some of the short-wave broadcasting bands, but certainly not for the ultra-high-frequency bands.

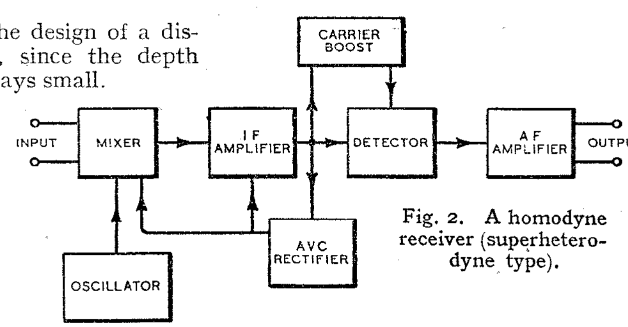


Fig. 2. A homodyne receiver (superheterodyne type).

Frequency-modulation, on the other hand, is precluded from working on the medium waves for two reasons:—

(a) It is very sensitive to distortion by fading, and in fact can only give good quality if the propagation from transmitter to receiver is limited to one path at a time.

(b) To secure the maximum advantage, the carrier must swing over a wide frequency range; for example, plus or minus five times the highest audio-frequency to be transmitted, and one cannot afford such a band-width on medium waves.

At present, therefore, it seems that the chief scope for FM is for broadcasting on about 40-50 Mc/s., and for highly-directional point-to-point relaying on much higher frequencies. Its advantages can be summarised as follows:—

(1) It reduces random noise (valve hiss and circuit noise) whenever there is a signal which is strong enough to come through above the noise.

(2) It reduces "impulsive noise" (clicks and bangs due to car ignition, atmospherics, sparking contacts, etc.) whenever there is a strong signal, and in any case *limits* the response to such noises to less than the response to a 100 per cent. modulated signal, even if there is only a very weak signal present or none at all.

(3) It reduces interference from other transmitters, including heterodyne interference, because a weaker carrier can modulate the desired carrier at an audible frequency only in proportion to something much less than the *square* of the ratio of the two carrier amplitudes; with American

standards of transmission, the heterodyne note would be over 30db. down for equal carrier amplitudes, and an additional 40db. for each factor of 10 in the ratio of the amplitudes. (E.g., heterodyne note 70db. below 100 per cent. modulation if the interfering carrier is one-tenth of the desired carrier, as against 20db. for a similar condition in an amplitude-modulated receiver.)

(4) If two FM stations work on the same channel with different programmes, interference is negligible wherever one transmission is received at a level 6db. above the other,

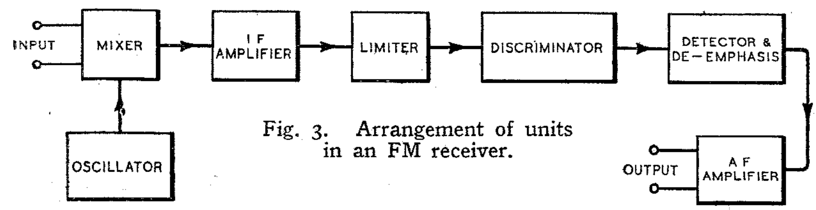


Fig. 3. Arrangement of units in an FM receiver.

whereas two different amplitude-modulated transmitters on a common carrier frequency require a difference of level of 40 to 46db. for freedom from interference.

Apart from the limitation to high carrier frequencies, the only difficulty with frequency modulation is that it requires new transmitters and new receivers, which are distinct from anything used at present for amplitude-modulated broadcasting. First of the features distinguishing the FM receiver from an ordinary receiver is the fact that it must handle a wide RF band, and the IF is, therefore, usually several megacycles, in place of the 465 kc/s. which is otherwise standardised for broadcast receivers. Then the IF amplifier must end with a *limiter*, to make the receiver insensitive to amplitude changes, which makes it unusable on ordinary amplitude-modulated transmissions, and the FM receiver will usually not have the AVC which is required on an AM receiver, since the limiter ensures constant output. Finally the FM receiver must have a *discriminator* (or "frequency-converter") to turn the frequency-modulation into amplitude-modulation before applying it to a pair of diode rectifiers which serve as detector. Consequently, it is only the AF section of the receiver that can readily be made common to both FM and AM signals, though there are one or two commercial receivers in which the IF tuned circuits are switched so as to give a wide band at, say, 4 Mc/s, followed by a limiter and discriminator for FM, or a straight amplifier at 465 kc/s for AM reception.

In the American FM broadcasting, the higher audio frequencies are boosted at the transmitter and cut at the receiver, a process which improves the signal/noise ratio (the boost and cut are known as "pre-emphasis" and "de-emphasis" respectively); the de-emphasis circuit is usually connected directly to the diodes of the FM detector, and, for AM working in the type of receiver with switched IF valves, a separate diode is fed from the IF amplifier and coupled directly to the AF amplifier. This "pre-emphasis" is especially beneficial in FM systems, because with FM the highest-frequency components of noise in the receiver are also the strongest, so that a top cut in the receiver eliminates a considerable amount of noise.

At the present moment there is no UHF broadcasting in this country, though before the war there was the "television sound" transmission; so if we were to follow "Free Grid's" suggestion and scrap all existing television receivers, it would be easy enough to use FM for the sound when restarting the television service (as is done in U.S.A.), and install some additional UHF sound transmitters. This combination of television and FM sound would have a further advantage; it would provide a greater incentive to buy television receivers, since the sound side of the receiver would be able to pick up high-fidelity alternative programmes on the "Television and FM" waveband during the whole of the usual programme hours.

On the whole, then, there seems a good case for going ahead with both developments, FM for ultra-high frequencies and homodyne receivers for the medium-wave band. Possibly the opening up of UHF broadcasting would make it possible to reduce the number of medium-wave transmitters, and so provide the wider carrier spacing which is necessary before even the homodyne can give really high-fidelity reception.

Code Practice Signals

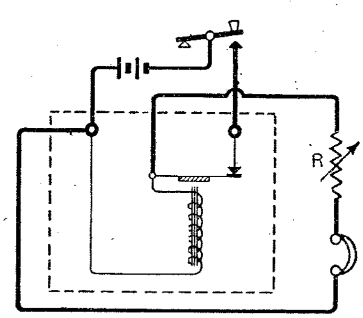
Uses of a Buzzer

As components for valve oscillators are scarce nowadays, there is a tendency to revert to the buzzer as a generator of artificial signals for morse practice. Compared with the valve oscillator, the buzzer requires more frequent adjustment, and the quality and controllability of the note are inferior. In spite of this, however, a good buzzer is satisfactory enough for the purpose, and an indifferent one can often be improved by substituting a lighter vibrating reed and armature, and also by fitting better non-corroding metal contacts.

It is, of course, possible to practise by listening direct to the buzzer, but it is generally preferred to simulate more nearly the conditions of actual wireless reception by using headphones. These may best be connected across the buzzer coil (or coils) in the manner shown in the accompanying diagram. A variable resistance R of from 50,000 to 100,000 ohms provides a control of volume. Instead of the resistance, a variable condenser of 0.0005 to 0.001 mfd. may be used; the higher value is readily obtained by "paralleling" the 0.0005-mfd. sections of a two-gang condenser.

Up to a dozen pairs of phones may be connected in parallel across the buzzer coils; the maximum number depends on the power output, and it may sometimes be increased by using an extra cell for energising the buzzer.

When the phones are of low resistance, or the various pairs are not of equal resistance, a series of series-parallel connection may be preferable. A volume-controlling device may not be necessary when a large number of phones are used.



A buzzer practice set, showing connections of key and phones. The internal wiring of the buzzer is shown in fine lines.

It should be realised that, as buzzers vary so much in their characteristics, the values given in this note may be subject to fairly drastic modification. The right value is best found by trial and error.

VALVE EQUIVALENT CIRCUIT

Notes on its Limitations

By
H. J. BOYLAND,
B.Sc. (Eng.), A.M.I.E.E.

THE valve equivalent circuit, which consists, neglecting inter-electrode capacities, simply of a generator producing μ times the voltage applied to the grid of a valve, and which is considered as operating on a circuit consisting of the load impedance in series with the AC impedance of the valve, has been widely employed. By its aid solutions to many problems involving the use of valves in circuits may be obtained. Nevertheless, from personal knowledge of the difficulties which students new to the subject experience, it would appear that the limitations and short-comings of the above simple "equivalent" should be set forth. In the

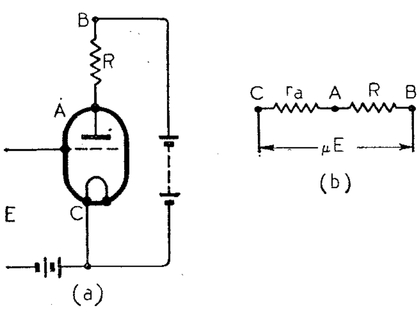


Fig. 1. The valve circuit (a) is conventionally represented by the equivalent circuit (b).

first place, it may be as well to point out that nothing can be the true equivalent of a valve, except another valve of the same type, and not always even then! The object of these notes, therefore, is to explain certain points which inviariably present difficulty to the beginner, and which receive but scant treatment in most textbooks.

Referring to the valve circuit shown in Fig. 1 (*a*), it is generally stated that if the grid bias be such that grid current does not flow, and also if the HT supply has such a value that operation of the valve is restricted to that part of the valve characteristic which can be considered linear, as regards the magnitude of alternating currents and voltages the actual valve circuit, neglecting inter-electrode capacities, can be replaced by the so-called "equivalent circuit" consisting of R and r_a in series, where r_a is the anode AC resistance of the valve, and which is subjected to an alternating voltage of RMS magnitude μE. This equivalent circuit is shown in Fig. 1 (*b*), where E represents the RMS signal voltage (assumed to be sinusoidal) applied to the grid, R is the load resistance and r_a is the anode AC resistance of the valve. Later in this article it will be necessary to distinguish another valve AC resistance, and hence r_a will be referred to as the "static AC resistance" of the valve, and is, of course, merely the reciprocal of the slope of the I_a, V_a characteristic over its substantially straight region. It is important to note that the circuit shown at Fig. 1 (*b*) is equivalent to the actual valve circuit *only as regards the magnitude of the alternating currents and voltages involved.* For example, in the actual valve circuit the alternating voltages across the load R and the valve are 180 *degrees out of phase, and always have the same magnitude,* so that, if the AC impedance of the source of HT supply is negligible, the alternating potential between B and C in the actual valve circuit is zero whatever the nature of the load. In the "equivalent" circuit the voltage between B and C is μE.

From considerations of power, it is also evident that the circuit of Fig. 1 (*b*) is not a true equivalent of Fig. 1 (*a*). Thus, if an alternating current of RMS value I_a flows through R and r_a in series we should have an AC power loss of $I_a^2\ (R + r_a)$; power which is not supplied by the input circuit, and which cannot be supplied by the DC high tension source. Indeed, on the assumption of linear operation of the valve, the power output from the battery is constant, whether a signal voltage be applied to the grid or not, and is given by the product of the average anode current and the battery volts, as will be referred to again later.

Consider the case of a valve without a load in the anode circuit. Fig 2 (*a*) represents the arrangement, and, if the valve be biased to $-$ E volts, the steady anode current with a battery voltage of V is given by PC. If now a signal voltage of amplitude E be applied to the grid, the anode current will vary between an upper limit of AC and a lower limit of BC. Neglecting any impedance the HT source may have, there will be no alternating voltage between anode and cathode of the valve. Hence, from an external point of view, the valve behaves as though its AC resistance is zero, since we have an alternating component of anode current but no alternating voltage. On the other hand, had an alternating voltage been applied in the anode circuit, this voltage divided by the resulting alternating current would give the anode AC resistance r_a, which is constant if the valve characteristics are linear. With any load in the anode circuit the voltage across the load plus that across the valve is equal to

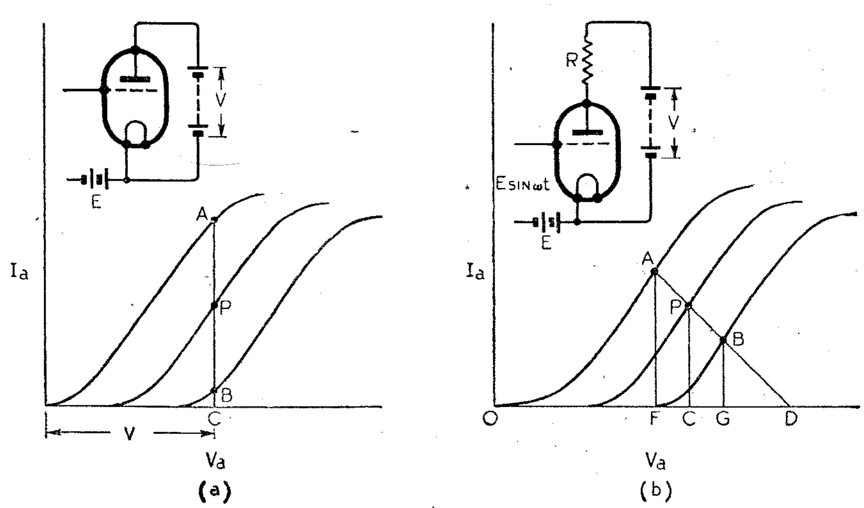


Fig. 2. Illustrating the case of a valve without and with an anode circuit load.

that of the HT DC source, and hence it follows that the alternating voltages across the load and valve must be in anti-phase, and of the same magnitude. Since the load has an impedance which is essentially positive, it is evident that the valve behaves as an impedance, the magnitude of which is equal to that of the load, but of opposite sign. This valve impedance will be referred to as its "dynamic impedance," the value of which is always negative and is dependent, not upon the valve, but upon the load. In the extreme case referred to above in connection with Fig 2 (*a*), the dynamic impedance is zero. Referring again to the circuit of Fig. 1 (*b*) the alternating voltage across the load is I_aR, and that across the valve is $-I_aR = I_ar_a - \mu V_g$.

Hence the dynamic impedance of the valve is $\frac{I_ar_a - \mu V_g}{I_a} = r_a - \frac{\mu V_g}{I_a}$, and this quantity is always negative except when $V_g = O$. If $V_g = O$, then the dynamic impedance of the valve is simply its AC resistance V_a. On the other hand, if the load resistance be zero, then $\frac{V_g}{I_a}$ is the reciprocal of the valve mutual conductance, and thence the dynamic impedance becomes $r_a - \frac{\mu}{g} = O$, as we have already seen. Due to the fact that the dynamic impedance of the valve is negative with an impressed signal, it follows that the AC power which appears in the load resistance is actually supplied by the valve, and that without an impressed signal this power constitutes an increased loss in the valve itself. A consideration of the following will make this point clear. Referring to Fig. 2 (*b*), if the load be a pure resistance of R ohms and if the input signal has an amplitude of E volts, equal to the grid bias, then the grid volts will vary between an upper limit of zero and a lower limit of $-$ 2E. The curves represent the valve characteristics for grid voltages of zero, $-$ E, and $-$ 2E. The HT voltage V is represented by OC and the load line AD is the volt-ampere characteristic of the load resistance R plotted backwards from the point G; i.e., the slope of the line is determined by the value of R, a voltage DC across the load resistance, for example, giving rise to a current PC = I_o through it. With no signal, the steady valve current will be PC, the anode-cathode volts OC, and the volts across the load resistance DC. Upon application of the signal the current will rise to an upper limit of AF and fall to a lower limit of BG, and if the valve operation is linear the anode current will consist of a steady current I_o together with a sinusoidal component $I \sin \omega t$; i.e., the anode current will be given by $i_a = I_o + I_1 \sin \omega t$.

With no signal

Battery output $= VI_o$;

Power loss in load resistance $= I_o^2R$;

Loss in valve = battery output $-$ loss in R $= VI_o - I_o^2R$.

With signal

Battery output = average of $V(I_o + I \sin \omega t) = VI_o$.

Power loss in load resistance

$= \text{average of } (I_o + I \sin \omega t)^2R$

$= \text{average of } (I_o^2 + 2I_oI \sin \omega t + I^2 \sin^2 \omega t)\,R$

$= I_o^2R + \frac{I^2R}{2}$

Power loss in valve

= battery output $-$ loss in **R**

$= VI_o - I_o^2R - \frac{I^2R}{2}$

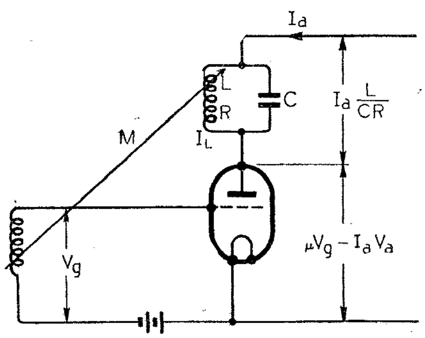


Fig. 3. **Showing conditions in a tuned anode oscillator circuit.**

Thus with an applied signal AC power of amount $\frac{I^2R}{2}$ appears in the load, and since the battery output has not changed, this means that the loss in the valve is reduced by a similar amount. If, for any reason, in a valve oscillator circuit, oscillations fail to take place, the anode of the valve, due to the increased losses taking place, may attain a dangerously high temperature. Upon commencement of oscillations, however, AC power appears in the load, the loss in the valve is correspondingly reduced and it may be possible to observe some cooling of the anode.

The fact that the valve "dynamic impedance" must be of equal magnitude but opposite sign to that of the load can be employed in order to deduce the conditions of oscillation for valve circuits. Take, for example, the tuned anode oscillator shown in Fig. 3. If sustained oscillations are to be possible the magnitude of the alternating voltage across the valve, which will be $\mu V_g - I_ar_a$ and in anti-phase to the voltage across the tuned circuit, must be equal in magnitude to this latter voltage. Now the effective impedance of the tuned circuit at or about resonance is $\frac{L}{CR}$. Hence for oscillations we must have $\mu V_g - I_aV_a = I_a\frac{L}{CR}$. But $V_g = \omega MI_2$ and

$I_2 = QI_a = \frac{1}{R}\sqrt{\frac{L}{C}}I_a$; $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

being the factor of merit for the tuned circuit. Hence

$$\mu\omega M\frac{1}{R}\sqrt{\frac{L}{C}}I_a - I_ar_a = I_a\frac{L}{CR},$$

or $\frac{\mu M}{RC} - r_a = \frac{L}{CR}$, since $\omega = \frac{1}{\sqrt{LC}}$.

This gives $M = \frac{L + r_aRC}{\mu}$, which is the minimum value of M for sustained oscillations. If the above calculation be carried through with impedances expressed in complex form instead of in terms of mere magnitude, the resulting solution will give an expression for the frequency of oscillation as well as the condition that must be satisfied in order that oscillations may occur. In this respect the example given is incomplete, since the LC circuit has been assumed to be equivalent to a pure resistance of value $\frac{L}{CR}$. This, of course, is substantially true if $\omega = \frac{1}{\sqrt{LC}}$ but the more complete analysis would show that ω has not exactly this value and that the load circuit must behave as a capacitative reactance if oscillation is to occur.

Conclusions

It is not suggested that general employment of the idea of a negative dynamic impedance would facilitate calculations relating to valves and their circuits. It will have been noted that in the example on the tuned-anode oscillator the familiar μ, r_a and g are still in evidence, as indeed they must be, since equating the valve dynamic impedance to that of the load fails to determine the magnitude of the valve current. This article will have achieved its purpose, however, if it has made clear the fact that the simple valve equivalent circuit is equivalent only in respect of magnitudes of voltages and currents, and not as regards their respective phase. Likewise, the equivalent circuit cannot be employed for power calculations. This circuit is, nevertheless, invaluable in the solution of numerical valve problems, but it is necessary to realise its limitations.

WIRELESS IN SCHOOLS

Equipment and Its Installation

By V. H. AUSTIN

THE following brief outline of radio as applied to schools, written from practical experience spread over a considerable number of years, may be of interest to those who are in any way connected with the installation of equipment for educational purposes.

Results obtained from the average radio set installed in elementary schools leave a lot to be desired, unless certain modifications are made to the output. One has to be present during a lecture reproduced by a typical installation, such as a domestic type of superhet, to realise how much more concentration is required to follow a speaker, as compared to a delivery in person.

Of course there is the psychological aspect, but apart from this, the type of reproduction given is practically opposite to that required. It has been found that, to obtain good intelligibility of artificial speech in the average classroom or hall, the output should have a rising characteristic from about 1,000 cycles, and cut off at about 200 cycles, whereas the domestic type of superhet has a very bad attenuation of the higher frequencies, due to ultra selectivity, and usually a heavy resonance in the lower register, which no doubt is necessary to lend the illusion of bass and tone coloration. Bass resonance is the most troublesome when attempting to overcome the acoustic properties of schools. From experience gained in many types of school buildings, it has been found most satisfactory to create a sharp cut-off in the region of 200 c/s; this greatly reduces boom and echo effects, and allows speech to be more readily followed. Selectivity of a high order is not necessary; this should greatly facilitate the design of tuned circuits to avoid high-note loss. An ideal arrangement would seem to be pre-tuned circuits with about six push buttons, as a very limited number of stations is required. The normal type of tone control should be replaced by a switch with positions denoted "Speech" and "Music."

A set for the reception of educational broadcasting, designed on lines advocated by the author. All controls are under lock and key, and general construction is heavy and robust.

Output Power

In the first position, a resistance-capacity network is brought into operation to restrict the bass output as described, whilst the second position should replace this with slight treble cut. This definite switching seems to be more readily understood than a control knob. A power output of 3½ to 5 watts is ample in the ordinary classroom or hall, as nothing seems to be gained (if the output is of the correct type) by raising the actual speech output above the normal of human speech in similar conditions. One extension speaker would be ample, as it is very rare that more than two classes require the same lecture at one time. In the modern type of school all classrooms are wired for loudspeaker extension, but it is generally agreed the best arrangement is for the set to be installed in the actual classroom used for listening, and the extension used only when it is necessary for an additional class to take the same subject.

Whenever it is possible for a selection to be made of the classroom where the set can be installed, the one as nearly square as possible is to be preferred from an acoustic point of view. The method of installation also plays an important part in the ultimate results obtained. The usual type of radiogram or console receiver is not favoured; not only does it take up valuable floor space, but the position of the speaker is not an ideal one, and much better results are obtained when the speaker is placed about four feet above floor level, thus enabling speech to get over without having to resort to an increase of volume.

Cabinet Design

The table type of cabinet lends itself most usefully, as the installation can be permanently fixed upon a shelf or bracket out of harm's way and yet convenient for use. For radiogram installations the table type of instrument is also favoured. A good design for this type of instrument is a cabinet of large enough dimensions to include a record storage compartment to hold two or three dozen records. An instrument built upon these lines which has proved a great success is shown in the accompanying photograph. The dimensions are:—30in. × 14in. × 14in.; apart from the built-in gramophone equipment, there is a compartment holding three dozen records.

For an aerial arrangement, no doubt the vertical rod type is the best; not only can this be installed in an elevated position on the modern type of building without becoming an eyesore, but the results obtained are very good. However, when this type of aerial is erected on a building, an efficient type of lightning arrester is most essential.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

STABLE DC AMPLIFICATION

High Sensitivity in an Instrument Designed for AC Operation

THERE is an increasing demand from biologists and engineers for a sensitive and stable type of amplifier capable of handling both alternating and long-period fluctuations of unidirectional current. Amplifiers of this type with direct-coupled stages are notoriously troublesome from the point of view of zero drift, and call for considerable skill in operation and adjustment if accurate and reliable readings are to be obtained.

In a recent paper[1] Mr. Stewart E. Miller analyses the causes of zero drift and discusses the design of a mains-operated DC amplifier with automatic compensation. One of the most important sources of fluctuation is grid drift, or, as the author terms it, cathode drift, due to changes in the temperature and the emission from the cathode. These may arise from changes in the surrounding temperature or from fluctuations of the heater current, and will cause changes of anode current even when the HT voltage and grid bias are held constant.

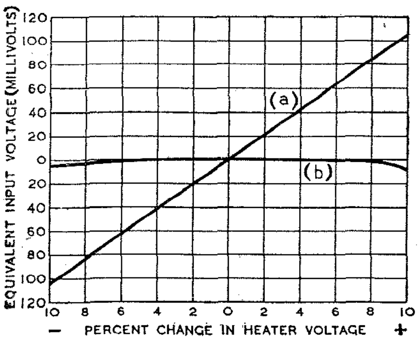


Fig. 1. Zero drift due to change of cathode temperature (a) in conventional amplifier, (b) in cathode control amplifier.

Control of heater current by a constant current transformer and barretter will do much to alleviate the drift, but some additional control for second-order temperature changes is essential if high sensitivity is required. In a typical single stage of a conventional DC amplifier the change of anode current resulting from a 10 per cent. change of heater voltage may amount to the equivalent of 0.1 volt change of grid potential (see Fig. 1).

The equivalent input voltage due to cathode temperature variation may be regarded as a fictitious internal EMF, V in series with the cathode (Fig. 2). This EMF will not be reduced by negative feedback, and is a form of tube

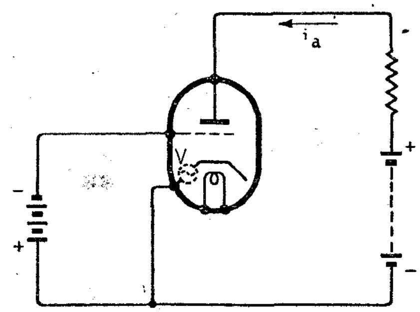


Fig. 2. Fluctuations arising from changes in cathode temperature may be represented by a fictitious internal voltage V.

noise. Theoretically it might be cancelled out in a push-pull circuit, but in practice the rate of heating of individual cathodes is always slightly different, and this would be sufficient to cause drift in so sensitive a circuit. The author's method of compensation makes use of a double-triode valve in which separate grids and anodes are associated with the same cathode.

The fundamental circuit is shown in Fig. 3 (*a*), the right-hand triode being the control valve. It will be seen that if the fictitious fluctuation voltage V is negative with respect to the input circuit, it will be positive with respect to the grid of the control valve, with the result that while i_1 decreases, i_2 will increase, tending to keep the cathode potential independent of V. If R_3 is made large compared with the AC resistance of the valve, the resultant change of potential (*e*) in the input circuit due to the fluctuation voltage V will be zero when $R_2 = 1/g_2$, where g_2 is the mutual conductance of the control section. If the two sections of the valve are not identical, a balance can still be obtained provided that the fictitious voltages are proportional. Thus, if V (amplifier) $= k$V (control), the condition for $e = o$ will be $R_2 = k/g_2$.

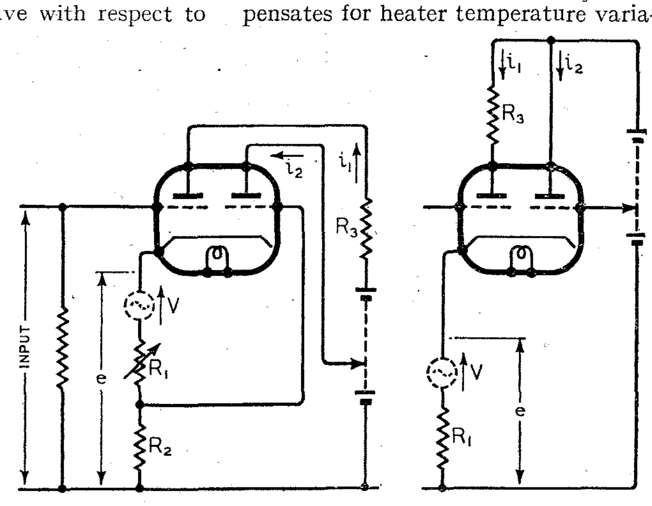


Fig. 3. (a) Basic circuit of cathode control amplifier. (b) Simplified circuit giving considerable reduction, but complete extinction of fluctuation voltage.

If one is prepared to accept a state of affairs in which *e* is never zero, but is small compared with V, the simplified circuit of Fig. 3 (*b*) may be adopted. In this the resistance R_2 is omitted, and the grid of the control section is given a positive bias with the object of making the value required for R_1 large. As a first approximation it can be shown that $e/V = 1/(1 + g_2R_1)$. In practice, values of $1/20$ to $1/75$ are obtained for e/V.

Voltage stage gains of 30 to 45 are given by these circuits under working conditions, the amplification being calculated for Fig. 3 (*a*) from the formula $\mu_1R_3/(R_3+r_1+r_2)$, and for Fig. 3 (*b*) from $\mu_1R_3/R_3+r_1+(\mu_1g_2)$ where r_1, μ_1 are the AC resistance and amplification factor of the amplifier section of the valve, and r_2, g_2 the AC resistance and mutual conductance of the control section.

Power Supply

It should be clearly understood that the cathode control circuit only compensates for heater temperature variations, and that for successful operation of the final amplifier a very stable HT supply is necessary. In practice the HT voltage must not vary by more than a millivolt, if instabilities of less than 10 microvolts referred to the

[1] *Electronics,* November 1941.

Stable DC Amplification—

input circuit are to be achieved.

The principle used in the stabiliser is the one in which a portion of the output voltage is compared with a constant voltage reference, the difference being amplified and impressed

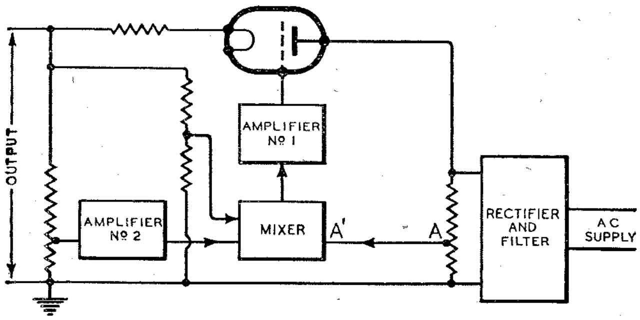


Fig. 4. Schematic circuit arrangement of stabilised power supply unit.

on the grid of an amplifier valve in series with the supply line, the phases being arranged to maintain the output voltage constant. A schematic diagram of the power supply unit is given in Fig. 4. It differs from common practice in having a forward acting connection AA_1 between the rectifier output and the mixer valve which enables perfect regulation to be obtained when the fraction of the rectifier output voltage fed through AA_1 is equal to the reciprocal of the product of the amplification factors of the control valve and the combined mixer and amplifier No. 1. The simplified degenerative cathode control circuit of Fig. 3 (*b*) is used for this amplifier as well as for the reference voltage amplifier No. 2.

The intervalve coupling circuits of the main amplifier presented special difficulties, since the overall gain of a million required before the application of degeneration, and the stipulation of an output voltage sufficient to work a cathode-ray oscilloscope ruled out the use of direct coupling. In designing a coupling with the requisite high impedances, the circuit of Fig. 5 (*a*) was taken as the starting point. R_1 is chosen so that the volt drop R_1i_1 is equal to the DC volts across the valve T_1. The transmission index of the coupling is $R_2/(R_1+R_2)$, so that to approach unity R_2 must be large compared with R_1. In order to fulfil this condition, and at the same time make the R_1i_1 drop equal to that across T_1, the negative voltage E_2 would have to be large compared with the drop across T_1. This is inconvenient, particularly as E_2 must be stabilised.

Acting on a suggestion by Mr. E. L. Norton, of Bell Telephone Laboratories, the author substituted a cold cathode glow discharge tube for R_1. Although the type chosen is rated for much higher currents it functions as a constant-voltage device for currents as low as 10 or 20 μA. Under these conditions R_2 could be made as large as 1 or 2 megohms with values of only 30 or 40 volts for E_2. The revised circuit is shown in Fig. 5 (*b*), from which it will be seen that the drop in R_2 is balanced by a conventional cathode bias resistance. The gas-discharge tube occupies the same position as a normal coupling condenser, and may be regarded as operating down to zero frequency.

Practical Details

The final circuit of the amplifier is given in Fig. 6. Sensitivity is controlled by the selector switch in the cathode circuit of the first stage. The third stage, comprising valves T_{11}, T_{12}, and T_{13}, as a form of direct-coupled voltage amplifier, is designed to give 40 volts across R_{43} with a current of only a few milliamps. A balanced output stage is employed, and switching in the cathode circuit enables current to be taken by an external load or an internal meter to be inserted for alignment of the circuit.

Since the effective maximum gain of the amplifier is over 100 db, care must be taken to shield leads in the

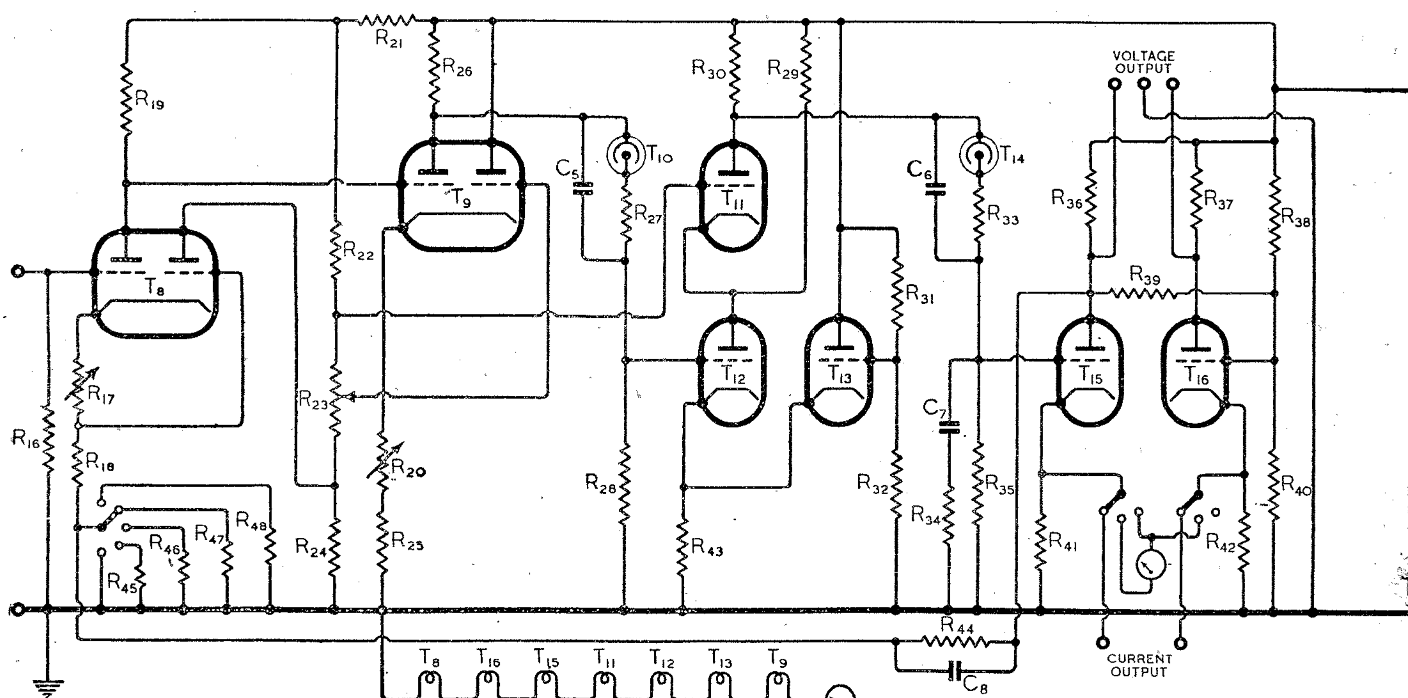


Fig. 6. Complete circuit diagram of amplifier unit.

early stages. The layout should be arranged to give good ventilation and avoid wide temperature changes in any of the resistances during warming up. Valves T_8 and T_9 in the amplifier and power supply unit respectively are mounted on sponge rubber valve holders.

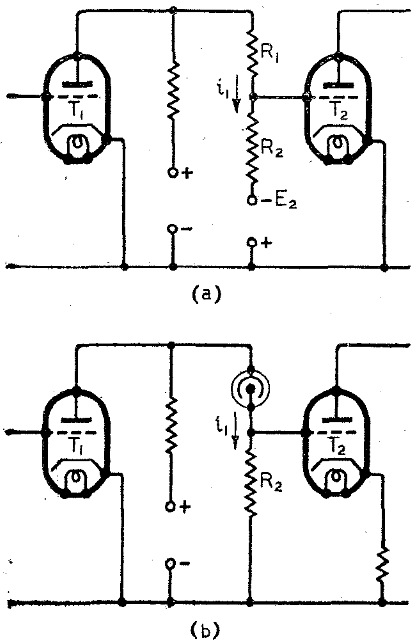


Fig. 5. (a) Basic intervalve coupling circuit. (b) Practical modificalion making use of cold-cathode gas-discharge tube.

On test the amplifier gave full output for inputs ranging from 0.35 to 10 millivolts, and the frequency response was flat from zero to 12,000 or 20,000 c/s, depending upon the sensitivity range in use. Distortion is less than 1 per cent. on the 1-millivolt range at 80 per cent. of maximum output; noise level is 4 μV peak with the input shorted or 16 μV peak with an input resistance of 0.5 megohm.

In the output circuit current and voltage terminals may be used simultaneously, the maximum voltage being ± 80 volts peak and the current ± 5 mA.

The complete circuit diagram of the power supply unit is given in Fig. 7. It will be seen that the filament current of the amplifier is stabilised as well as the HT voltage, which leaves the cathode control circuits to deal with ambient temperature changes. Variation in the normal 110-volt supply between 95 and 125 volts did not produce more than 0.4 millivolt, while the residual AC component in the 250-volt DC supply to the amplifier was only 0.5 millivolt. The regulating process breaks down below 92 volts, on a nominal 110-volt line, but as this is likely to be of only rare occurrence it cannot be regarded as a serious deficiency in an otherwise sound design.

Component Data for Figs. 6 and 7

Resistances

Metallised
- R_1 10 MΩ
- R_2 100Ω
- R_3 2 MΩ
- R_7 0.5 MΩ
- R_9 0.5 MΩ
- R_{10} 50,000Ω
- R_{12} 2 MΩ
- R_{15} 0.1 MΩ
- R_{26} 0.5 MΩ
- R_{27} 50,000Ω
- R_{28} 1.0 MΩ
- R_{29} 0.2 MΩ
- R_{30} 0.5 MΩ
- R_{31} 0.5 MΩ
- R_{32} 0.1 MΩ
- R_{33} 10,000Ω
- R_{34} 50,000Ω
- R_{35} 1.0 MΩ
- R_{38} 1.0 MΩ
- R_{39} 1.0 MΩ
- R_{40} 0.11 MΩ

Carbon variable
- R_4 1.0 MΩ

Nichrome Wire
- R_5 25,000Ω
- R_6 50,000Ω
- R_{13} 50,000Ω
- R_{16} 0.47 MΩ
- R_{25} 50,000Ω
- R_{36} 8,000Ω
- R_{37} 8,000Ω
- R_{41} 8,000Ω
- R_{42} 8,000Ω
- R_{43} 15,000Ω
- R_{44} 151,000Ω

Low Temperature Coefficient Wire
- R_8 100,000Ω
- R_{14} 75,000Ω
- R_{18} 1,000Ω
- R_{19} 0.5 MΩ
- R_{21} 40,000Ω
- R_{22} 20,000Ω
- R_{24} 30,000Ω
- R_{45} 1.04Ω
- R_{46} 3.62Ω
- R_{47} 11.0Ω
- R_{48} 37.4Ω

Wire-wound Variable
- R_{17} 2,000Ω
- R_{20} 10,000Ω
- R_{23} 10,000Ω

Condensers
- C_1 8 μF electrolytic
- C_2 0.006 μF paper
- C_3 0.05 μF paper
- C_4 0.5 μF paper
- C_5 0.03 μF mica
- C_6 0.01 μF mica
- C_7 0.0001 μF mica
- C_8 0.00003 μF mica

Valve Types
- T_1 5T4
- T_2 T_3 T_4 2A3
- T_5 T_6 12SC7
- T_7 VR-105-30
- T_8 T_9 12SC7
- T_{10} T_{14} VR-150-30
- T_{11} 12SF5
- T_{12} T_{13} T_{15} T_{16} 12J5GT

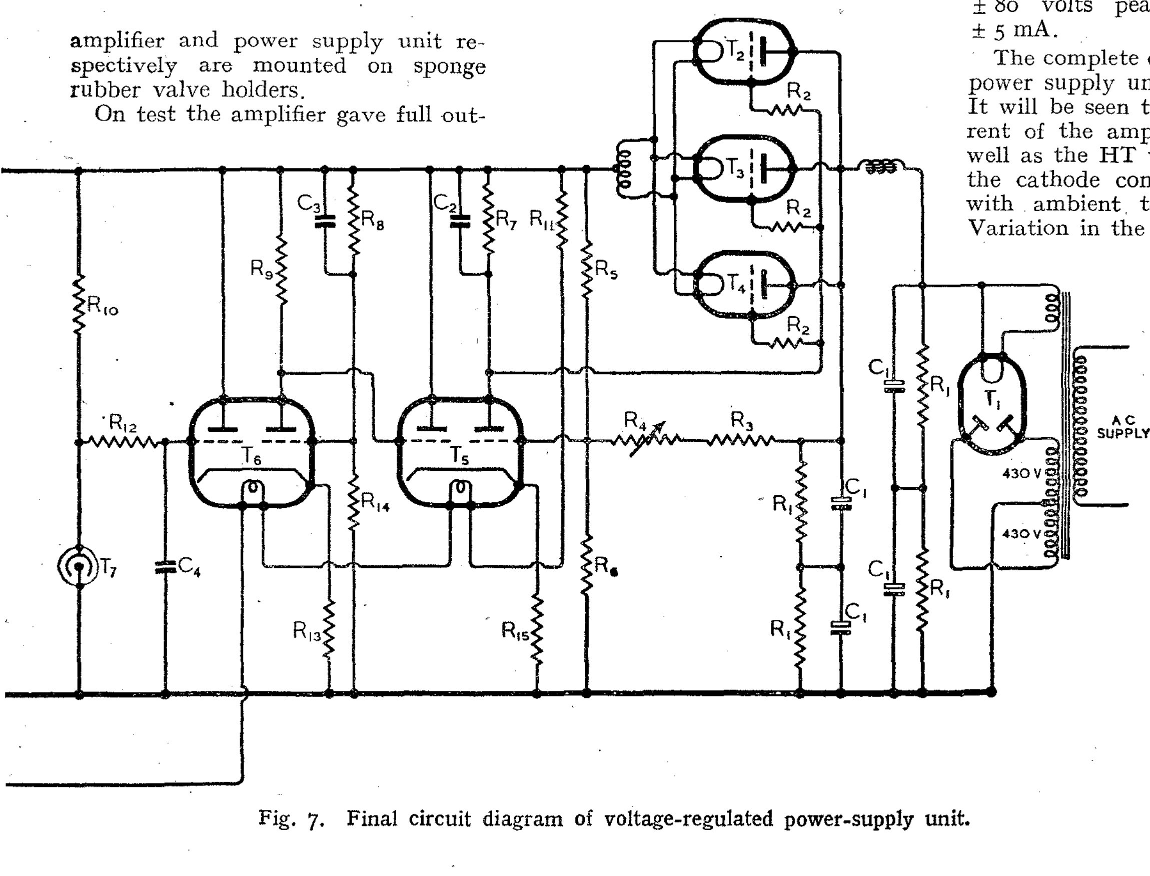


Fig. 7. Final circuit diagram of voltage-regulated power-supply unit.

UNBIASED

By

FREE GRID

Music in a New Light

I AM not overmuch given to listening to the blathering bleatings emanating from the Axis propaganda stations. The reason is not because it is for the most part such poor stuff, but there is no law against my listening to it, and there seems, therefore, little object in doing so.

Mrs. Free Grid, however, does tune in the stations both in the enemy and enemy-occupied countries. The reason is not that she favours an Axis victory —indeed, I doubt whether she intends to let either side win—but that she and her friends are music addicts, and the European stations do, so she tells me, put out some first-class music.

I was sitting humbly in the inglenook the other night while she and a party of her friends were acclaiming some new work which was being churned out by a station, the name of which, for reasons which will be apparent later, wild horses will not drag from me. They were remarking upon what an unusually and beautiful "rhythm and tonal balance" the new work possessed. Even to my untutored ear it certainly did sound unusual.

As I sat half listening and half dozing by the fire, I suddenly sat up, and seizing pencil and paper began to write feverishly as I listened to the music. Mrs. Free Grid and the other ladies present smiled benignly upon me and muttered some gibberish about my ears being at last opened to the divine afflatus which inspired the great masters. It was, however, something far different which was inspiring me, and as the tempo of the music grew, my pencil, moving feverishly over the paper, was scarcely able to keep pace with it, so great was my excitement.

At last the music came to its appointed end, and I laid down my pencil with a sigh. It was as I had suspected. The "unusual rhythm and tonal balance" was nothing less than a lengthy message in morse, cunningly woven into the music by this new composer.

The message was, of course, in cypher, and it was not until later, when I had taken it to an expert, that I realised its full import, and I marvelled anew at the ingenuity of the man who had thought of this altogether new and hundred-per-cent. safe method of getting complete details of German troop movements and other information vital to our cause out of his enslaved country.

Needless to say, I lost no time in getting in touch with the proper authorities, and after interviewing innumerable office boys and minor officials who twice left the important message in a car which was stolen, I succeeded in getting to the ear of the right person, and from now on a proper watch will be kept on all musical items broadcast from stations in Europe. Those of you who know morse can all help in this, and those of you who don't know had better start learning it straight away.

La Vie T.S.F.

I DON'T mind admitting that I received a bit of a shock the other morning when I saw *Wireless World* in its new ultra-modern cover. In fact, when I saw it on my breakfast table I angrily summoned the maid and bade her run round to the newsagent with it forthwith and remind him that I was a respectable family man, and did not indulge in this sort of literature.

It was not until she came back with a message from the newsagent to the effect that he, too, was a respectable family man and he hoped I wasn't insinuating that he was in any way responsible for it that I took a second look and realised that it was *Wireless World* and not *La Vie Parisienne* or anything like that.

The divine afflatus

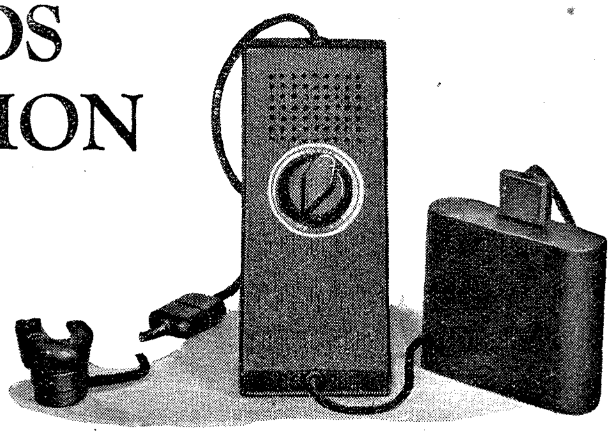
Needless to say I at once dived into its pages and it was with a sense of unfeigned relief that I saw that it was still its staid old scientifically accurate self. The new cover at any rate compels attention, like the domestic articles with which undergraduates have from time to time adorned the spires and pinnacles of their respective *Almae Matres*; in fact, on second thoughts I found that it not only compelled my attention, but I rather liked it, and I sent the Editor a telegram of congratulation and requested to know who had suggested it to him, as I didn't suppose he had thought of it himself. So far I have had no reply.

Katahode and All That

THE author of "Homodyne Reception," in the April issue, very wisely prefaced his article with a little explanation of the derivation of the word homodyne. Possibly he might have felt that some of the less-cultured among you, knowing how fond wireless is of horrible hybrid words like television, might have concluded that it was an article on man power, and have rung up Mr. Bevin about it. If wireless derivations seem a little slovenly at times it is, I fear, merely a reflection on the appalling slackness in spelling and suchlike matters which we see all around us. In my young days it was considered *de rigeur* to spell Burmah as I have just spelt it, and anybody who didn't do so simply labelled himself as not being a *Pukka Sahib*.

To the modern generation, the omission of the "h" doesn't seem to matter any more than in the case of the word an*h*ode. No doubt the omission dates back to the word electr*h*ode, when the letter was certainly a bit awkward. There is one thing about the words cathode and anode as I suppose I must spell them, and that is I admire the genius of the man who used them first in electron tube terminology as it leaves no doubt in the mind of the student as to which way the current flows, and I think that it would be a great advantage if we used them in place of the meaningless positive and negative when referring to the terminals of batteries, etc. Ignorance of Greek would stop the positive-to-negative diehards objecting as it obviously has in the case of valve terminology.

HEARING AIDS FOR THE MILLION



By C. M. R. BALBI, M.I.E.E.

The author, who was for many years Honorary Electrical Consultant to the National Institute for the Deaf, urges that all deaf persons should be given the benefit of recent advances in hearing aid design by the mass-production of instruments to sell at low prices. It is contended that the wireless industry is best qualified to manufacture the aids, and that they should be distributed and maintained by wireless dealers

A Possible Post-war Development

ONE of the effects of war is to drive scientific development underground. But, judging from the last war, every technique undergoes some change during its period of hibernation. It is therefore of some interest to speculate on possible post-war lines of development of the hearing aid.

Those who have been closely connected with hearing aids observed with interest the attention that was being paid by the radio industry in 1939 to the technical developments of the various accessories connected with these instruments, such as valves and batteries. Further, certain wireless manufacturers had themselves marketed instruments for sale to the public, both direct and through the trade. No doubt this would have been extended as the demand grew, but the development would have been gradual, as the wireless dealer already had a surfeit of regular lines to handle. Moreover, apparently no manufacturer thought it worth while to launch a national advertising campaign to make the general public hearing-aid minded.

After the war the vast hearing-aid market will no doubt appeal to a number of manufacturers as a possible extension of their activities, and so the views of one who has had a long-standing interest in the subject may prove of interest to both public and manufacturer alike.

The present position regarding hearing aids is not unlike that of the broadcast receiver of the early days. If we look back to the years immediately preceding the war we find that the retail price of a radio broadcast receiver of good performance was stabilised between ten and fifteen pounds. But this was not always so; some fifteen years earlier, two-valve receivers were being sold at fifty pounds, with loud speaker extra.

The technical advances made and the low price reached were possible because manufacturers set out to cater for the million. We may ask why the hearing aid, which follows miniature radio receiver practice so closely, has remained so long in the state of expensive individual production. The hasty observer invariably replies that it is because the commercial field is so limited, compared with that of radio, but certain experts consider the hearing-aid market is the bigger of the two. Statistics are not available as to the number of deaf people in existence, but the *British Medical Journal*[1] quotes a figure of six and a half millions in this country as having impaired hearing. This is considered to be a very conservative estimate. A well-known doctor once put the matter far more convincingly when he said that there were as many people in need of a hearing aid as were wearing glasses.

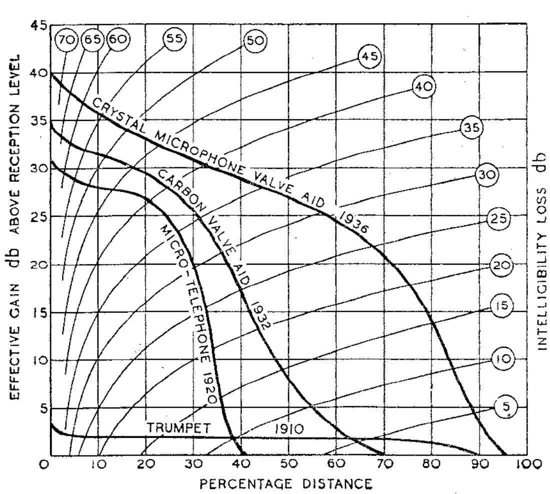


Fig. 1. Chart for predicting the effectiveness of hearing aids of various types.

Now I do not want people to think that there is a market waiting for six and a half million hearing aids without qualification. If spectacles were as clumsy as telescopes to wear, no matter how efficient in restoring correct vision such instruments were, the market would be strictly limited.

Every factor has a bearing on the matter, particularly weight, size, efficiency, simplicity, cost and upkeep. My object is to indicate that the obstacles which have prevented mass production have now been overcome.

Assessing Performance

It can be said that the purpose of a hearing aid is to restore acuity to normal when deafness occurs, but it is known that nothing less than a laboratory amplifying system of large size and considerable cost will achieve this; therefore, all deaf aids fail in their purpose in a greater or less degree.

Recently this general statement has been expressed in scientific terms which enables us to assess or predict the benefit to be derived from any aid in relation to a person's deafness. When the results are expressed graphically, as in Fig. 1, the fact emerges that with the best kind of valve-type hearing aid, a very close approximation to normal hearing can be obtained with at least ninety per cent. of deaf people, but previous types of

[1] An Estimate of the Incidence of Defective Hearing in England and Wales, *B.M.J.*, July 3rd, 1937.

Hearing Aids for the Million—
instrument fell short of this by varying degrees.

The trumpet of about 1910 was light, simple and inexpensive, and helped at long range, but only for the slightly deaf, as it had very little amplification. The micro-telephone of *circa* 1920 was powerful, but only efficient at short range. The valve-aid which graduated from the carbon microphone (1932) to the piezo-electric instrument (1936), with a corresponding advance in efficiency, has culminated in a design which is highly compact, simple, and efficient to use. Such a design can be seen in the accompanying photographs.

From the foregoing it can be observed how the increase of efficiency has also increased the scope and usefulness of these instruments as designs advanced. The early aids only served the few, while the present type has an extended range which suits the many and by experience is found to assist ninety per cent. of deaf people.

The graphs of Fig. 2 show how public demand has risen with increase of efficiency and in spite of high prices. The matter is of interest as it indicates the trend of future demand.

It is to be remembered that the number of people using hearing aids is a mere fraction of the potential total that it would reach if the price was in the region of, say, four to five pounds. This price, of course, can only be achieved by mass production.

Technically, we are not far from the ideal aimed at, and the ninety per cent. coverage which it embraces is sufficient justification for the public to demand revolutionary methods in marketing and service.

The prototype illustrated has three stages of amplification, and with the special type of valve now available a speech output of about sixty milliwatts can be obtained from a small high-tension battery of under forty volts combined in a single unit with a 1½-volt LT dry cell.

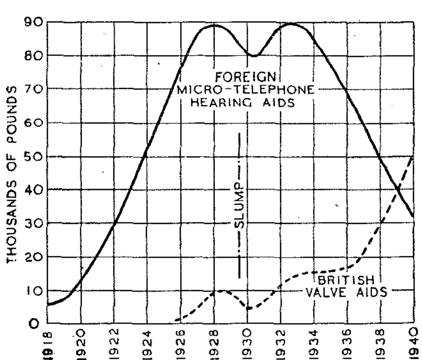
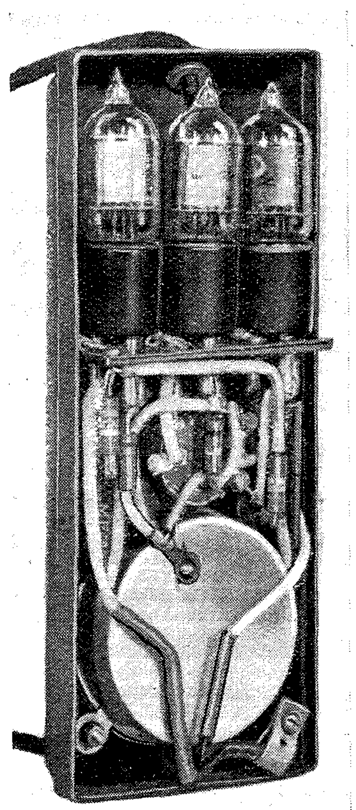


Fig. 2. Showing increase in the sales of valve aids.

The size and weight of the complete intrument has been reduced to a degree where it has become unobtrusive,



Showing how valves and components are mounted inside the hearing aid illustrated on the preceding page. It is the prototype of an instrument designed by the author for large-scale production. It measures 5½in. by 2¼in. by ¾in.

and the user can get accustomed to the instrument without noticing any encumbrance; hence we have arrived at the point where it only remains for a change of policy to convert a high-priced article produced on a small scale into a world-wide commodity within the reach of every deaf person. How this will be accomplished depends only on the views of the different manufacturers, but the writer is certain that it will be a wireless manufacturer, and hopes that it will be a British one.

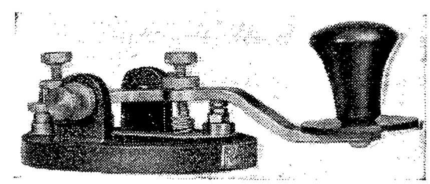
There is every indication of support from the medical profession for an improved instrument at a low price. Only an established service like the radio industry could offer it at a really popular price, but it must be remembered that the radio industry is far from being hearing-aid minded, and that it will undoubtedly remain in this state unless publicity in all its forms are concentrated in bringing this new service to reality.

American Pattern Key

For Morse Practice

THERE are subtle differences between British and American practice in telegraphy. For instance, the typical American key has a cranked bar fitted with a small flat knob, and so is convenient for the method of manipulation where the operator's forearm rests on the bench, the key being mounted about 18in. from its edge. But that method is not generally approved by British instructors, and the view is sometimes expressed that the use of an American key encourages a style that does not fit in with our technique. It is freely admitted, however, that the design of the key confers rigidity and freedom from sideplay; it also makes for lightness.

No objection can be urged against the British-made Raymart "Speed" key, a specimen of which has been submitted to us for test. The usual flat American knob has been replaced by a taller one of the British pattern, and there is no tendency to manipulate the key by methods other than those approved in this country. The key is rigidly constructed and is extremely light in action; being fitted with heavy silver contacts, it is suitable for serious work and can be recommended either for practice purposes or otherwise.



Raymart "Speed" Key.

The key, which costs 8s. 6d., is obtainable from Radiomart, Ltd., 44, Holloway Head, Birmingham, 1.

Abstracts and References

TRIBUTE to the vital part played by the Abstracts and References section of our sister journal, *Wireless Engineer*, is continuously being paid by authors and research workers. Compiled by the Radio Research Board, and published each month in *Wireless Engineer*, the section, which in the April issue occupies 27 pages, includes abstracts from and references to articles on wireless and allied subjects recently published in the world's technical journals.

The April issue, which is obtainable to order through newsagents, or direct from our publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d. (including postage), also contains articles on the retarding field oscillator, velocity modulating grids and the temperature compensation of condensers.

ELECTRONS IN U-H-F VALVES

III. Some Recent Amplifiers and Oscillators

In the first part of this article we began by discussing transit time as a factor which prevents the use of conventional valves for centimetre wavelengths; the second article was occupied with the properties of the unconventional closed resonators which have to replace the usual coil and condenser circuits at U-H-F. We propose now to show that if such resonators are excited by an electron beam, transit time may be utilised instead of evaded, and practical amplifiers and generators may be designed for powers which would be unattainable from ordinary apparatus at such high frequencies

By MARTIN JOHNSON, D.Sc.

THE departure point of the new technique for generating power at U-H-F is best illustrated, we think, in the amplifier of Haeff and Nergaard from the Radio Corporation of America: it provides the link between the basic principles which we have discussed and the more fully developed tubes using velocity modulation such as the Klystron.

Consider a coaxial resonator of the kind described in the preceding article, but only a quarter-wavelength long. The space between inner and outer cylinders is a resonating enclosure which can contain electromagnetic oscillations of definite frequency. The inner cylinder may be hollow or solid so far as resonator properties are concerned, and need only be tunnelled to admit a cathode-ray beam. If a metal plate closes one end of the resonating space, we have at that end the typical short-circuited termination, while the break separating inner and outer cylinders at the other end gives open circuited termination, with the consequences previously discussed. These secure that the reflections at the shorted end mark the position of an antinode in the magnetic field and a node in the electric field, while the reflections at the open end mark a minimum of magnetic field and a maximum of electric field.

As we showed, the existence of these reflections gives rise to a stationary system of waves, with the electric and magnetic fields $\frac{1}{4}$-cycle out of phase with each other, whereas if the coaxial tubes formed part of a transmission line terminated in its characteristic impedance, they would carry travelling waves in which the fields would be in phase both as regards time and space. As in the diagrams of our last article, the energy in the stationary system appears alternately in the electric and the magnetic form at intervals of $\frac{1}{4}$-cycle, so that in the $\lambda/4$ (quarter-wavelength) resonator the location of maximum density of magnetic lines is at the closed end and of electric lines at the open end, the resulting current flow being back and forth along the outer surface of the inner conductor and along the inner surface of the outer tube.

It may be noted that if both ends were to be short-circuited, the smallest length for standing waves is $\lambda/2$, and the $\lambda/4$ resonator must have one end behaving as "open."

Fig. 1 shows the idealised picture on which we base the mechanism, and Fig. 2 the single re-entrant shape which can be used in practice where "open-end" reflections and fields are provided by the "gap" or annular slit in the inner tube. The directions of the E lines of the electric field are determined by always ending perpendicular to a conducting surface.

Having thus fixed a likely mode of electrical vibration for this resonator, consider what happens if along its axis (now made hollow) there passes an electron beam from a "gun," similar to that of a C-R tube used for television. Any electron moving along the beam induces its own positive image charge on the inner surface of the inner tube (Fig. 3); but eventually after about 10^{-9} sec., or other interval, depending on the acceleration voltage, it crosses the gap at the open end. When this has happened the image must reappear on the inner surface of the extension to the outer cylinder. The transfer of these charges, from opposite the electron at A to opposite the electron now reaching B, involves a migration back along the conducting path which parallels the gap: this appears as a current flow along the common internal surface of the resonating space, i.e., along the exterior of the inner and the interior of the outer cylinders.

So far this is merely a geometrical picture of inductive coupling between an electron stream and the circulating current round a resonator, and hence the electromagnetic field in its hollow space. But we next have to notice that the electron moves in a shielded region while enclosed by the inner tube, and, therefore, does no work and has no work done upon it. On the other hand, while crossing the gap AB, it could either give up energy to any field in the gap or gain energy from having work done by the field. Such a field across the gap is partly due to the electron's motion itself, but may also be due to excitation of the resonator by any deliberate or accidental coupling to outside. It will either be decelerated or accelerated while crossing the gap, according as the net electric field is from B to A or from A to B, each of which conditions will occur in turn in each cycle of the resonator's vibrations, whether

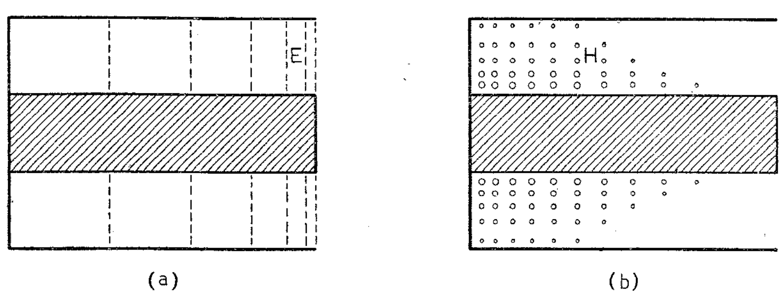


Fig. 1. Standing waves in a quarter-wavelength resonator. (a) The energy at this instant is in the electric form (E lines dotted). (b) $\frac{1}{4}$-cycle later: the energy is in the magnetic form (circles representing cross-sectional cuts at right angles to the H lines).

Electrons in U-H-F Valves—

the latter are excited by the passage of intensity-modulated groups across the gap, or by some direct input to the line from an aerial.

Finally, instead of a single electron, consider the whole cathode-ray beam. Energy will on the average be transferred from beam to field in the resonator if a greater number of its electrons cross the gap in the portions of the cycle during which they are decelerated, compared with those crossing during acceleration. This condition is fulfilled if the periodicity with which any modulation is imposed on the beam by grid impulses or otherwise is synchronised with the natural frequency of the resonator, and if the phasing is arranged so that the dense groups cross the gap during the instants of reversed field. If this is done, there is a vigorous transfer of energy from the unidirectional current of the beam to U-H-F in the resonator, and the slowed electrons are left to fall into some collector electrode beyond the gap.

It must be remembered that very short wavelengths have already been attainable, if power beyond a watt or two is not sought, so that the essence of our problem is either power amplification or generation at high power. The impulses to be amplified must therefore be fed to the beam or to the resonator, and in the Haeff apparatus this is done by a grid not far from the cathode. This grid provides intensity modulation by pulses from some U-H-F source such as a small Magnetron which requires amplification; but other valves, particularly the Klystron, obtain their impulses through the resonator instead of through the beam, so at this point we may profitably consider the ways by which this can be arranged.

Input and Output Terminal Devices.—Ideally the "Höhlraum" resonator of any shape is a completely enclosed space, the region of the field being perfectly shielded, there being no field outside, but for practical purposes it must be coupled to its output load such as an antenna. For very short waves this might be a tiny dipole situated at the focus of a metallic mirror for highly directional projection. Further, for receiving signals it is often desirable to excite the resonator without mounting Haeff's grid in the beam itself. A coupling loop or a probe is commonly used for all these connections between internal and external fields.

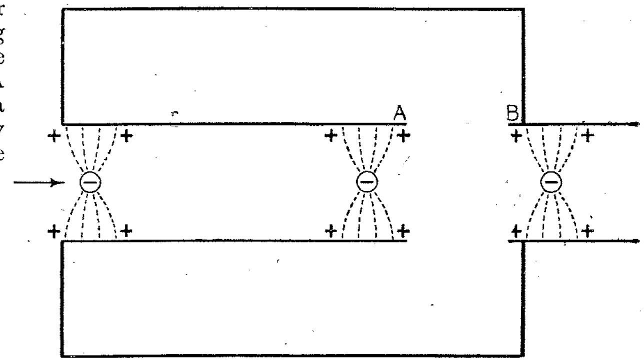


Fig. 3. Induction of the image charge by an electron moving along a cathode-ray beam in a quarter-wavelength resonator.

A probe, consisting of a straight rod projecting into the resonator at such orientation as to lie tangential to possible lines of electric force, can be a convenient terminal for exciting the electric field in various modes of oscillation. A closed loop, on the other hand, provides coupling with the magnetic field if its orientation allows it to be linked by magnetic lines; the degree of coupling may therefore be adjusted by rotating the loop into different directions. In finding that one end of such a loop can be in metallic connection with the resonator's surface, we are reminded that the entire "Hohlraum" and its terminal devices are at a common potential so far as DC is concerned.

Limitations.—Much of the research and the literature dealing with beam-excited resonators is occupied with the focusing of the beam and the attainment of initially homogeneous electron velocities: in the complex fields of a region like the "gap" there is sharp bending of the electric lines and scattering of the stream both in intensity and velocity. With carefully designed electrodes and resonator, divergence and convergence of the electron paths may be utilised to ensure that straying is corrected at each stage. The power advantage of such tubes compared with conventional valves will be sacrificed if the electrons actually touch the resonator, not only through impact heating but through the secondary electrons emitted at such contacts.

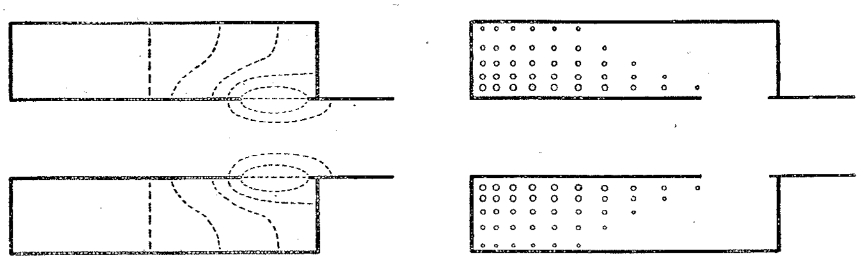


Fig. 2. **Typical quarter-wavelength resonator with gap in tunnel. Conditions are similar to Fig. 1 and (b) is ¼-cycle later than (a).**

Haeff and Nergaard claimed their device as a wide-band amplifier. This is probably justified since, if the input frequency is altered, amplification can still be maintained if the accelerator voltage is adjusted so that the greater number of electrons still cross their gap at the suitable instant for deceleration; but in constructing a $\lambda/4$ resonator for a given frequency it is not easy to decide which is the "length" of line to mark the quarter-wave distance. Is the "gap" to be included or excluded? The lines of force in Fig. 2 bend too gradually to decide this question, and rough calculations have been based on adding a loading capacity at the gap to modify estimations of the length.

Hansen devised an ingenious but complicated way of improving on these calculations, but it is often necessary to introduce some tuning device or to modify the calculated voltage if high "Q" is to be attained at the desired frequency.

To obtain high "Q" in $\lambda/4$ resonators used for the generation of U-H-F there is the same problem of uncertainty, or even broadening in the frequency spectrum. This is one of the reasons why the Klystron, to which we now turn, has been more used. Unlike the Haeff tube which amplified a grid input, the Klystron can be a generator as well as amplifier; but it employs a radically different kind of resonator as well as different input coupling. The design has been considered difficult to understand, but we suggest that it becomes clearer when approached by extending a little the ideas implied in Haeff's amplifier.

Velocity Modulation.—Suppose that the input of impulses to the grid in Haeff's amplifier were removed, so that there were no periodic intensity modulation and nothing to amplify. Instead of groups of electrons crossing the gap at the correct time for deceleration there would then be a steady stream approaching the gap from the gun side, but it would be unable to convert its energy into oscillation so long as it remained homogeneous. Actually no stream is perfectly homogeneous in velocity or intensity, and the least fluctuation in either must result in some degree of potential fluctuation across the gap. These fluctuations will not build up to great amplitude if they originate only in random irregularities of the stream, but if one of the coupling devices described above is allowed to feed U-H-F direct to the resonator a periodic slowing and hastening of successive cross-sections of the stream will occur.

Consider what happens if the beam containing such enforced non-uniformity is allowed to progress beyond the resonator, and the final collecting electrode of Haeff is replaced by a "drift space" ending in a second resonator and gap before any of the beam is gathered into a collector. The non-uniformity, or deceleration and acceleration of different succeeding regions of the beam, will constitute velocity modulation, a tendency for the electrons to sort themselves into bunches because some have become able to catch up their predecessors and leave behind their immediate followers. If the "drift space" is long enough for these separations to reach (and not to over-reach) a maximum, the beam arriving at the second resonator will be bunched into groups: an intensity modulation produced here by velocity modulation from the first resonator as effectively as it was produced in Haeff's tube by input to the grid.

If the second resonator can build up a field, some fraction of whose power output is fed back in order to excite the first resonator, the whole device regenerates any initial inhomogeneity in the electron stream, and forms an oscillator which can be a source of high power at U-H-F. If, on the other hand, an external source such as a generator or receiving aerial feeds the first resonator, the system can function as an amplifier or as a detector.

The two resonators are known at Stanford University, California, where they were first combined in this way, as "buncher" and "catcher," in accord with what we have described as their working in mutual interdependence. The whole valve has become known as a Klystron (from the Greek verb "klyzo," expressing the breaking of waves on a beach).

The Toroidal Resonator. — The brothers Varian first made tubes of the Klystron type. In selecting shapes for their resonators, which they called rhumbatrons, they chose a very different design from the $\lambda/4$ line of the Haeff tube, which had been derived from transmission line conventions. A hollow sphere has always had mathematical conveniences, but its natural frequency of resonance is that of a wavelength $\lambda = 1.14d$, where d is the diameter. The time to complete a whole cycle of oscillation would be λ/c, where c is the velocity of free radiation, 3×10^{10} cm. per sec. The field will reverse in half this time, $0.57d/c$; but electrons can move with speeds up to any fraction of c and can never actually reach c even at the highest voltage, a limitation due to the fact (known to relativity physics) that the inertia of an electron ceases to be a constant at high speeds and increases so that at c it would have become infinite. Hence the time to cross a sphere along a diameter will be always greater than d/c, and no electron will ever get across without experiencing reversal of field. For this reason a sphere is an unsuitable rhumbatron for excitation by the transit of groups of electrons, since any deceleration effects will be partly cancelled by a reversal giving acceleration.

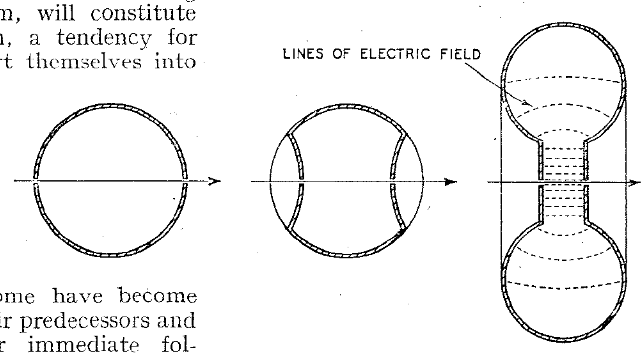


Fig. 4. Distortion of spherical resonator to a practical form with shorter electron path.

The obvious thing to do is to shorten the path across the sphere, and the Varian brothers pinched in their resonators by squeezing along a diameter until the cross - section

(*Continued on next page.*)

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X-RAY TRANSFORMER, 110/220 v. A.C. input; output 45,000 volts at 7 milliamps., as new, small portable type. **£12/10/-,** carriage forward.

ROTARY CONVERTOR, vertical type, 220 v. D.C. input; output 150 volts at 150 watts, complete with transformer for 110 to 240 volts, complete with starter, stand good overload. Price **£6/10/-,** carriage forward.

AUTO TRANSFORMER, 1,500 watts, tappings 0-110-200-220 and 240 volts for step-up or step-down. Price **£5,** carriage paid.

110 V. BULBS 150 C.P., Ediswan screw fitting, half watt gas-filled, **2/6** each, post free, or **22/6** per doz., post free.

FRACTIONAL H.P. D.C. MOTORS, for 110 volt and 220 volt D.C. mains only, from 1/20th to ⅛ h.p., state size and voltage required. Price **10/-** each, carriage 1/-.

LARGE TRANSFORMERS for rewinding, rating unknown, size 1 kW. auto. Price **17/6,** carriage paid.

LARGE TRANSFORMERS for rewinding, size 2 kW. auto., rating unknown. Price **30/-,** carriage forward.

HIGH-VOLTAGE CONDENSERS, size 4in. by 4in. by 10in., 1 mf. 4,000 v. working. Price **15/-,** carriage.

HIGH FREQUENCY TRANSFORMERS, 75 v. A.C. input at 300 cycles; output 5,000–0–5,000 v. at 500 watts. Price **45/-,** carriage forward.

10 K.W. AUTO TRANSFORMER in case, 110 v. to 220 v. or vice-versa, in new condition. Price **£15,** carriage forward.

AIR PRESSURE GAUGE, 9 in. dia., scale 0–4,000 lbs. per square inch, in gunmetal. Price **£4** each.

4-PIN BASE BOARD VALVE HOLDERS, good condition. 3/6 per doz., post free.

3 K.W. AUTO TRANSFORMER, tapped from 0 to 100 and then every 10 volts up to 300 volts, condition as new. Price **£10.**

ROTARY CONVERTOR, D.C. to D.C.; input 220 volts D.C.; output 12 volts at 50 amps. D.C., ball bearing, condition as new. Price **£10** carriage forward, or 17/6 pass. train.

DOUBLE OUTPUT GENERATOR, shunt wound, ball bearing, maker "Crypto"; output 60 volts at 5 amps. and 10 volts at 50 amps., condition as new. Price **£10** carriage forward, or 20/- passenger train.

ALTERNATOR, output 220 volts, 1 ph., 50 cycles at 180 watts, will give 1 amp. easily, speed 3,000 r.p.m.; self-exciting, condition as new. Price **£8** carriage forward, or 15/- passenger train.

TRANSFORMER, input 230 volts, 50 cycles, 1 ph.; output 1,100-0-1,100 volts at 220 milliamps. and 6 volts C.T. three times, earth screen, wound to B.S.R., weight 32 lbs. Price **£6,** carriage passenger train 7/6.

Electrons in U-H-F Valves—
reached the third stage in Fig. 4, where the arrows show the path of electrons through the resonator. The final shape has a circular section perpendicular to the diagram, and is reminiscent of a balloon tyre whose bulging rim covers as much area as the central plane of the wheel. The evolution of this shape may also be traced from successive distortions of a transmission line, with the regions of greatest current density area stretched to provide greatest surface area for the flow.

Bunching Mechanism of the Klystron.—We can now picture more usefully some of the essential detail of the complete Klystron, arranged (*a*) as amplifier of external impulses, and (*b*) as generator, by means of the alternative methods of coupling shown in Fig. 5.

If a U-H-F impulse of small amplitude, e.g., from a receiving aerial, is fed to the coupling loop A, an alternating field will be set up in its resonator, since the loop is perpendicular to the magnetic lines for the particular mode illustrated in Fig. 4. This field will impose velocity modulation upon the electrons passing through, as it is concentrated between the grids G_2 and G_3 of the rhumbatron. Since the gun and the first grid G_1 had aligned the beam at right angles to G_2 and G_3, the parallelism and the bunching of the beam is greatly superior to that obtainable in the $\lambda/4$ line, where the curved lines of force have to effect both bunching and focusing. In essence, the conception of the hastening and retarding of electrons is similar to that which emerged from the discussion of Haeff's tube. Final output is led away by the loop B in the periphery of the second rhumbatron.

When functioning as oscillator, the feed back is effected by the third coupling device C. All these terminal devices are miniature coaxial lines, so as not to radiate or pick-up except when they end in antennæ.

It will be noticed that the conception of transit angle, found useful in the earliest of these articles for measuring a nuisance in conventional valve design, here becomes equally convenient for deciding whether power is gained or lost, now that transit time is being utilised to good purpose. Let the first rhumbatron be excited by any means from outside as amplifier or from the second rhumbatron as oscillator, then consider an electron from the DC gun which happens to pass the centre of the U-H-F field just as the latter changes from opposing to accelerating. Its own speed is little altered, but another electron a few degrees ahead in transit angle is decelerated, while another a few degrees later is accelerated. If the length of the drift space is nicely adjusted, the two companions to the original electron ahead and behind have drawn nearer to it, while another electron of unmodified speed passing the grids 180 degrees earlier or later will have its neighbours ahead and behind drawing away from it; hence the regions of high and low intensity succeed each other and drive the second rhumbatron.

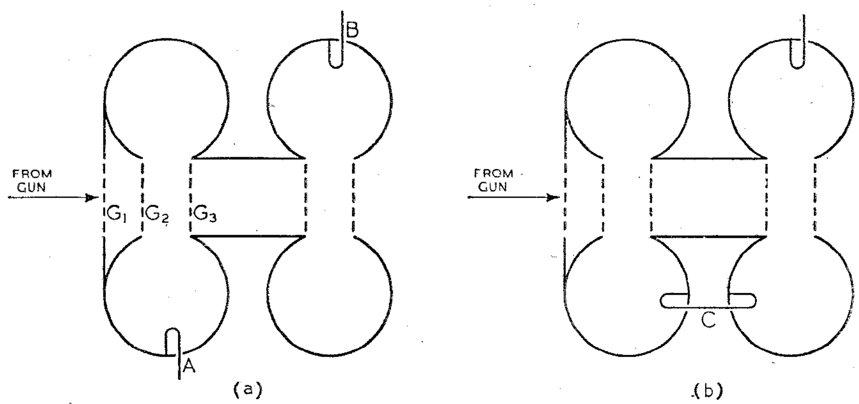


Fig. 5. The Klystron: (a) as amplifier, (b) as oscillator. A, B, C are coupling loops for the magnetic field.

It is clear that the two resonators must possess such phase difference between them that in the "buncher" the field introduces its fluctuations into the motions of the electrons without net gain from them, while in the "catcher" the electrons mainly give up energy to the field. To act as amplifier the "catcher" must gain more than the buncher loses on all counts, dissipative and otherwise. Webster has shown that a maximum of 58 per cent. of the DC power of the cathode-ray beam could be converted to U-H-F if the field strengths in the "catcher" were such as to reduce the slowest electrons just to standstill. He has also made calculations of "de-bunching" and other inefficiencies, knowledge of which is invaluable when developing practical apparatus.

For use as detector, a final grid beyond the "catcher" may have a potential nearly that of the cathode, allowing a collector beyond just to accept current: on arrival of a signal input the velocity modulation process results in a slowing of some of the electrons which therefore fall to this final grid or back to the "catcher," and the collector current is observed to drop.

It will now be realised that the overheating of conventional tubes at high power is avoided in all these inductive devices, since the electrodes which accept power are not those which accept current, and vice versa. For this reason we are now able to convert a large fraction of the power from a heavy beam driven by kilovolts, whereas at U-H-F the ordinary valve is usually limited to fractions of a watt. Transit time, the controlling factor, as always, can be utilised and shortened at will by such high voltages as no conventional valve would permit.

While the above simplified account contains the essence of inductive conversion of DC power to U-H-F, the acute problem of phasing for correct use of transit time involves a vast mass of development before high power becomes available. For accounts of such details as have been published, the following list of articles may be of service:—

References

Haeff: *Electronics*, Feb., 1939.
Haeff and Nergaard: *Proc. I.R.E.*, March, 1940
Hahn and Metcalf: *Proc. I.R.E.*, Feb., 1939.
Barrow and Mieher: *Proc. I.R.E.*, April, 1940.
Varian and Varian: *Journ., Applied Physics*, May, 1939.
Hansen: *Journ. Applied Physics*, Oct., 1938, Jan., 1939, March, 1939.
Webster: *Journ. Applied Physics*, July, 1939.

Paper Salvage

QUESTIONS sometimes arise as to the suitability for repulping of paper or paper-board that has been coated, impregnated or otherwise treated for electrical work. Where an appreciable quantity of such waste is available, the problem can be referred to the Waste Paper Recovery Association, 154, Fleet Street, London, E.C.4. (Telephone: Central 1345.) Where necessary a sample of the material should be sent. Do not forget that the need for salvaging every scrap of paper is still a vital concern of everyone.

Letters to the Editor

Technical Training

MOST of Mr. Ledward's remarks in the April *Wireless World* on Technical Training are based on a misrepresentation of a passage from my letter in the February issue. I wrote: ". . . three years' thermionics is equally absurd. My students acquire all that is necessary in six hours, or less." As thermionics is a small branch of radio engineering, this statement appears quite sound to me; but in the hands of Mr. Ledward it becomes: "Subaltern's statement that he can train a person in a few hours," which is quite ridiculous, and bears no resemblance to what I wrote.

In the light of this correction, some of Mr. Ledward's other points—as to the type of work for which my students are qualified and as to whether they could pass the City and Guilds Final examination—appear less important. In any case, they could hardly be discussed in public, but if Mr. Ledward is still interested, I shall be happy to communicate with him privately. "SUBALTERN."

Wire or Wireless ?

I FULLY appreciate the objections raised by correspondents to Mr. Eckersley's "pro-wire" suggestions, but I feel that those suggestions can be easily dismissed. The first point made by this distinguished engineer in your January issue would alone justify further consideration.

Many humbler workers than Mr. Eckersley have been driven to adopt similar convictions. I remember much discussion being caused by a paper read by me before an Educational Association in 1926, outlining a scheme of "wired wireless." Even at this early date the system seemed to many to offer the only solution for overcrowding and interference with essential services.

Should some such scheme (in, perhaps, a modified form) serve to relieve congestion, I do not believe that the specific interests of any section of radio personnel would arrest its development. Surely no one can look forward with satisfaction to a post-war orgy of jostling side-bands.

I confess to some surprise at certain remarks of Mr. J. W. Pollock in his interesting letter, since the Association he represents would be assumed to have the safeguarding of all mobile communications very much at heart.

I do not, of course, wish to be regarded as a champion of the mobile services at the expense of other facilities. I do not, for instance, condone the action of the authorities who permitted 300-watt spark transmitters to be fitted in coasting vessels in prewar days. E. C. WILLIAMS.

Handforth, Ches.

The Editor does not necessarily endorse the opinions of his correspondents

Extemporised Morse Practice Oscillator

THOUGH I have been a constant reader of your journal for some considerable time, I cannot remember ever seeing a simple means of obtaining a morse practice signal from an ordinary domestic receiver.

A device I am using at present consists of feeding the anode end of the external speaker sockets back to the grid socket of the pick-up through a 0.0001-mfd. condenser and a megohm resistance. The condenser is on the anode side, the key and the resistor being plugged into the pick-up socket. The volume control gives a very useful range and the note obtained is very suitable for the purpose.

Different resistances and condensers will, of course, be necessary with certain receivers. I am using a 6Q7 and 25L6 amplifier for this experiment. The arrangement still works satisfactorily when the external speaker terminals are connected to the secondary of the output transformer.

For sets without external sockets at all, an experimenter with only a little knowledge should be able to find the anode and grid leads and bring them out to a plug so that he can easily attach the key. D. SKLOVSKY.

London, S.W.14.

Morse Chart

OUR publishers are issuing a Morse Chart which has been prepared by the staff of *Wireless World* to meet the need of small groups of A.T.C. or Home Guard wireless trainees, and for similar training purposes. The chart includes the morse code alphabet and numerals in large type. Information on morse key manipulation, instructions for wiring buzzer practice sets and hints on learning the code are also given. The chart, which will be ready shortly, costs 6d., or 7d. by post, from Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

PREMIER RADIO

ELECTROLYTIC CONDENSERS

8MF 320 v. **Wet Can** type, **3/-** each.
25MF 25 v. .... **1/6** 50MF 12 v. **1/6**
50MF 50 v. .... **2/6** 8MF 125 v. **1/6**
U.S.A. Type Valves. 6V6G, 6K7G, **12/10** each. 6A8GT, **14/1.** 6H6G, **6/9**, 25L6G, **15/-.** Many other types available. Send for lists.

RESISTANCES

2,000 ohms 25-watt Res., with 5 Tapping Clips, **2/-** each.
1 ohm ± 1%, suitable for Bridges, **5/-** each.

NEW PREMIER S.W. COILS

4- and 6-pin types now have octal pin spacing, and will fit **International Octal** valve holders.

4-PIN TYPE			6-PIN TYPE		
Type	Range	Price	Type	Range	Price
04	9–15 m.	**2/6**	06	9–15 m.	**2/6**
04A	12–26 m.	**2/6**	06A	12–26 m.	**2/6**
04B	22–47 m.	**2/6**	06B	22–47 m.	**2/6**
04C	41–94 m.	**2/6**	06C	41–94 m.	**2/6**
04D	76–170 m.	**2/6**	06D	76–170 m.	**2/6**
04E	150–350 m.	**3/-**			
04F	255–550 m.	**3/-**			
04G	490–1,000 m.	**4/-**			
04H	1,000–2,000 m.	**4/-**			

CHASSIS MOUNTING OCTAL HOLDERS **10½d.** each.

Premier 2-Gang S.W. Condenser, 2×00015 mfd., with integral slow motion, complete with pointer, knob and scale, **10/6.**

SHORT WAVE CONDENSERS

Trolitul insulation. Certified superior to ceramic. All-brass construction. Easily ganged.
15 m.mfd. .... **2/4** 100 m.mfd. **3/-**
25 m.mfd. .... **2/6** 160 m.mfd. **3/7**
40 m.mfd. .... **2/6** 250 m.mfd. **4/-**

BAKELITE DIELECTRIC VARIABLE CONDENSERS

.0005 mf. Suitable Tuning or Reaction, **1/9** each.

S.W. HF. CHOKES

10–100 m., **10½d.**
High-grade **Pie-wound** type, 5–200 m., **2/6** each.

MOVING COIL SPEAKERS

Celestion, 8in. P.M. Speaker, **25/-.**
Goodmans 8in. P.M. Speaker, **25/-.**
Plessey 8in. 2,000 ohms field Speaker, **15/-.**
All speakers are complete with output transformer.

PREMIER MICROPHONES

Transverse Current Mike. High-grade large output unit. Response 45–7,500 cycles. Low hiss level, **23/-.**
Crystal Microphone. Rothermel D. 105, 63/-.

PREMIER REPLACEMENT VALVES

4-volt A.C. types, 5-pin. ACHL, ACSG, **5/6** each.

"LEARNING MORSE?"

Then purchase one of the new practice Oscillators. Supplied complete with valve, on steel chassis **27/6.** Practice key, **3/3,** TX key, **5/9.** Brown's Headphones, **17/6** pair.
3-Henry Chokes, 10/-.

PREMIER BATTERY CHARGERS FOR A.C MAINS

Westinghouse Rectification, complete and ready for use. To charge 6 volts at 1 amp. (also tapped for 2 and 4 v.), **29/6.**
12v., 1a. (also tapped for 2 and 6 v.), **37/6**
6 v. at 2a. (also tapped to charge 2 and 4 volts), **48/-**

MATCHMAKER UNIVERSAL OUTPUT TRANSFORMERS

Will match any output valves to any speaker impedance. 11 ratios from 13–1 to 80–1, 5/7 watts **20/-.** 10/15 watts. **26/-.**

PREMIER MAINS TRANSFORMERS AND SMOOTHING CHOKES AGAIN AVAILABLE

Write for Details.

ALL ENQUIRIES MUST BE ACCOMPANIED BY 2½d. STAMP.
ALL ORDERS LESS THAN 5/- 6d. POST EXTRA.

PREMIER RADIO CO.

ALL POST ORDERS to:
JUBILEE WORKS, 167, LOWER CLAPTON ROAD, LONDON, E.5. (*Amherst 4723.*)

CALLERS to:
JUBILEE WORKS, or 50, HIGH STREET, CLAPHAM, S.W.4. (*Macaulay 2381.*)
169, FLEET STREET, E.C.4. (*Central 2833.*)

THE WORLD OF WIRELESS

LONDON'S P-A SYSTEM

THE success of London's Warship's Week is largely attributed by the War Savings Committee to the sound-distribution system used throughout the week. Both speech and music originated from a single source under the joint control of the Post Office and the B.B.C., who provided a normal input into the lines at zero level equalised to approximately 7,000 c/s. From the studio, which was in Faraday Building, the transmissions were relayed to 18 points scattered throughout the square mile of the City.

Due to the rather long lines that were necessary, losses of up to 30 db were encountered in some cases; in others with shorter runs the received level was only 6 db below that transmitted, so that it was essential that transmission measurements be made and line losses tabulated. Balanced attenuators were provided before the input of the voltage amplifiers on each site to reduce the level to about 1 mV into 600 ohms, this being their normal loading value. Furthermore, these amplifiers incorporated a 10 db lift at 7,000-8,000 cycles to improve the clarity of speech and music transmitted.

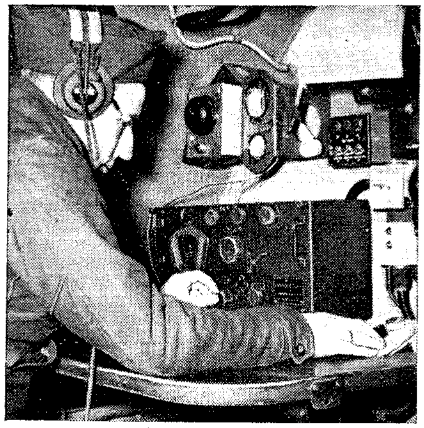
Tannoy 60-watt amplifiers in triplicate were provided at each line terminal to avoid any possibility of failure, though in no case were more than two required to deal with the speaker load, due to the high conversion efficiency of these units.

The speakers employed were reactance-compensated PM horn-loaded Tannoy units with built-in matching transformers. Five watts per speaker were needed for adequate coverage.

P. K. TURNER

WE regret to record the death of Philip K. Turner, M.I.E.E., at the early age of 53, on March 16th. He was for a short time prior to 1925 editor of our sister journal, *Wireless Engineer*, which was then known as *Experimental Wireless & Wireless Engineer*, and was also the first editor of our contemporary, *The Wireless Trader*.

"P. K.," as he was known among his friends, had a facility for the use of mathematics and he successfully brought it to bear upon problems in wireless and acoustics. He was associated with H. A. Hartley in the production of the high-quality moving-coil loudspeaker which bore their two names; also amplifiers and receivers.



RADIO OPERATOR at the controls of a U.S. Army Air Corps bomber. Note the American method of keying with the forearm supported.

SIR WILLIAM BRAGG, O.M.

THE regretted passing of Sir William Bragg, O.M., at the age of 79, on March 12th has removed from the world of scientific research a great and respected physicist.

Many have been the appreciations of his great qualities which have appeared in the scientific Press. Those who have heard him lecture will agree that he had an unusual aptitude for simplifying complex questions.

His work in the fields of research, which he did not seriously begin until he was forty, has been deservedly recognised. His extraordinarily wide outlook in scientific matters made him an able chairman of many committees on diverse subjects.

"It is science itself, not scientists, that we are trying to lift to the high places," is one of the utterances which summarises Sir William's outlook on his researches.

It was Sir William's appreciation of the place of science in everyday life and in industry that led him to accept many of his appointments. From 1935 to 1940 he was president of the Royal Society, and at the time of his death was director of the Royal Institution.

U.S. TELEVISION

THE result of the conference of the United States Federal Communications Commission to decide the fate of television for the duration of the war is not known at the time of going to press.

Television is being used by the New York civil defence organisations for the purpose of training personnel.

NEWS IN MORSE

IN addition to the normal broadcasts of news in English for the Continent, the B.B.C. recently announced the introduction of news bulletins in morse. Transmitted at a rate of approximately 12 words a minute, they should be easily readable. Their main object is to ensure the reception of news on the Continent in spite of Germany's efforts at jamming.

The transmissions, which are radiated for half-hour periods on 49.59 and 261.1 metres, are scheduled for 12.30 a.m. English, 1.0 a.m. French and 1.30 a.m. German. The times are GMT.

Readers are also reminded that official news bulletins in morse are radiated from the Post Office stations. Although no changes have been made since last we gave details of the schedule in these pages they are repeated for the convenience of those interested in receiving them, if only for practice purposes.

The call signs and the wavelengths employed for these transmissions, which are intended for oversea, are:—

GIA:	15.27 m.
GAD:	15.40 m.
GBL:	20.47 m.
GID:	22.13 m.
GIH:	28.17 m.
GAY:	33.67 m.
GBR:	18,750 m.

The times (GMT) of the transmissions and the transmitters used are:—

0930: GBR, GIA, GID, GIH.
1200: GBR, GAD, GIA, GID.
1600: GBR, GAD, GIA, GID.
1930: GBR, GAY, GBL, GID.
2330: GBR, GAY, GIH.

For the transmissions at 1200 and 1600 the transmitter GIA has its aerial directed to South America. The aerial used by GBL for the 1930 transmission is also directed to South America, but this transmitter closes down at 2000, and the transmission is continued by GBR, GAY and GID.

BATTERY CHARGING

IN addition to the difficulties already encountered by the service-man regarding batteries, valves, components and labour is that of the serious delay in obtaining replacement heavy-duty mercury-vapour rectifiers for commercial battery chargers, writes *The Wireless and Electrical Trader*.

The maintenance of a large proportion of the receivers in some districts depends upon the uninterrupted operation of accumulator charging plant. If this employs mercury-vapour rectifiers—as many do—then the shortage of these valves, which is now making itself felt, may well put a large number of sets out of commission for some time.

The Trader points out that the situation does not rest entirely with the valve manufacturers, who already have a long list of outstanding orders which they cannot execute. It would be but a simple matter for the Board of Trade, who has stated that it appreciates the importance of maintaining receivers, to give directions for the manufacture of a moderate number of these rectifiers to meet the demands.

AMERICAN REPLACEMENT VALVES

THE production of a limited number of replacement valves for receivers will be continued in the United States. It has, however, been decided to reduce the number of major manufacturers of such valves from the present seven to one or two. In this way essential materials will not be wasted in the production of unnecessary old types of valves.

The production of valves is being reduced in the same way as receivers for civilian use. The present reduction is of 42 per cent. of the average monthly output for the first nine months of 1941. It is anticipated that the cut will be increased after April 23rd to 58 per cent.

TRANSMITTERS FOR BOMBER DINGHIES

IN reply to a recent question in the House of Commons asking whether SOS transmitters are supplied to R.A.F. bombers for use in their rescue dinghies, similar to those which have been long in use in enemy machines, Sir Archibald Sinclair, Secretary of State for Air, gave the following answer: "Wireless sets have been issued for trial purposes for some time. A set of satisfactory performance is in production, and will shortly be issued for general service."

AMERICAN S-W BROADCASTING

THE recent disagreement between the American Government and the owners of the country's international short-wave stations is likely to be settled in the near future. The original plan, to which exception was taken by the broadcasting companies, called for almost complete control by the Government.

It is learned from *Broadcasting* that the alternative "Paley Plan," which is being considered by the special Government committee, provides for the grouping of the country's short-wave stations into two organisations, thus maintaining the competitive spirit which seems to be an essential part of broadcasting in the States. The control of the stations would be left in the hands of the present experienced staffs, and would not be transferred to a Government-appointed controller as was originally planned.

There is, however, an objection to the Paley Plan. It is that the country's short-wave facilities are said to be too limited to divide them.

IN BRIEF

News from China

BY the end of April a new broadcasting station at Chungking, China, is expected to begin transmissions beamed on England. This was announced by Mr. F. Y. Chai, of the Chinese Embassy, when speaking at the Radio Industry Club luncheon on March 25th. A schedule of the transmissions of news in English from the existing 35-kW station is given in "News in English from Abroad."

Television Patents

AN agreement between the R.C.A. and the Don Lee Broadcasting System for the interchange of television patents was recently announced.

"The Greeks Had a Word for it"!

THE use of the words "repair" and "overhaul" by service-men is deprecated by the Scottish Radio Retailers' Association, as they may be misunderstood by the public to imply a guarantee that a set should function satisfactorily for some considerable time after having been "repaired" or "overhauled." The Council of the S.R.R.A. has strongly advised the use of the words "service" or "servicing."

Swedish Listeners

AT the end of 1941 Sweden had 1,550,000 licensed listeners, which, according to statistics, means that every fourth Swede has a licence. This indicates that Sweden is maintaining her position of first among European countries in receiver density.

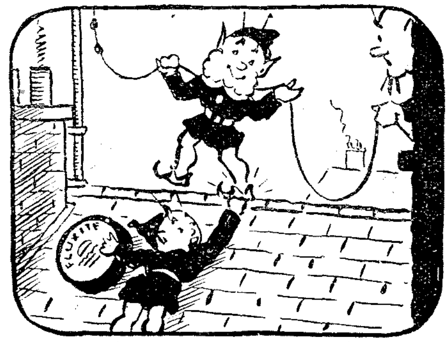
Pooling Valve Supplies

THE possibilities of a scheme for the pooling of valves by dealers is being explored by the Scottish Radio Retailers' Association, the scheme being that service-men who have certain types of valves which they are not requiring may sell them through the "pool" to those dealers who require them and are unable to obtain them through the normal supply channels.

Component Manufacturers

THE expansion, dispersal and changes in methods of manufacture of components introduced during 1941, which are reviewed in the latest report of the Radio Component Manufacturers' Federation, are stated to be to an extent scarcely equalled by any other industry of comparable size and complexity. It is a fortunate circumstance, the report

(*Continued on the next page*)



The "Fluxite Quins" at work

"Don't worry—I'll mend it," cried EH,
"Done worse things than this in my day.
Where on earth is that lad
With the FLUXITE, begad?"
"You're standing on him!" shouted they.

See that FLUXITE is always by you—in the house—garage—workshop—wherever speedy soldering is needed. Used for 30 years in Government works and by leading engineers and manufacturers. Of Ironmongers—in tins, 4d., 8d., 1/4 and 2/8.

Ask to see the FLUXITE SMALL-SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6.

Write for Free Book on the art of "soft" soldering and ask for Leaflet on CASE-HARDENING STEEL and TEMPERING TOOLS with FLUXITE.

TO CYCLISTS! Your wheels will NOT keep round and true unless the spokes are tied with fine wire at the crossings AND SOLDERED. This makes a much stronger wheel. It's simple—with FLUXITE—but IMPORTANT.

THE FLUXITE GUN

puts Fluxite where you want it by a simple pressure. ***Price 1/6, or filled 2/6.***

FLUXITE LTD.
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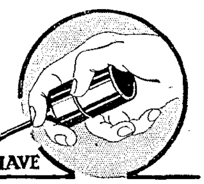


ALL MECHANICS *WILL* HAVE

FLUXITE

IT SIMPLIFIES *ALL* SOLDERING

The World of Wireless—

states, that in times of peace acute competition and the speed of technical developments combined to make the manufacturers highly versatile and adaptable.

Salving Batteries

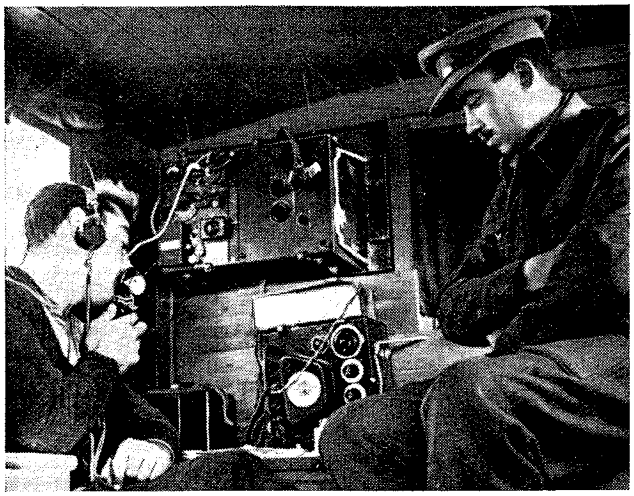
A NEW department to deal with salvaged dry batteries is to be created by the Aberdeen City Corporation. It is stated that the prices offered for salvaged batteries is such that the creation of the department will be an economic proposition.

Standard Servicing Charges

A SYSTEM of standard servicing charges is being considered by the Scottish Radio Retailers' Association. A list of charges is to be prepared and submitted for consideration at a future meeting of the S.R.R.A. Council.

HT Batteries: Price Increase

AN increase of twenty per cent. in the retail price of high-tension and all-dry batteries marketed by members of the Association of Radio Battery Manufacturers was introduced on April 1st. The brands affected by the increase are:—C.A.V., Drydex, Ever Ready, Oldham, Pertrix and Siemens.



ARMY-R.A.F. CO-OPERATION. The use of planes for target spotting has been considerable in the Libyan campaigns. At 4,000ft. above the target the pilot is able to direct the fire from the battery, which may be 6,000 yards from the objective, via the operator of a R.A.F. mobile ground station similar to that shown in this photograph.

Rehabilitation Scheme

A SCHEME for the training of disabled men and women from the Forces as radio testers and repairers was recently inaugurated at the Leith Technical College, Edinburgh. This scheme, sponsored by the Ministry of Labour and the Edinburgh Education Authority, which will also provide facilities for the training of civilians disabled as a result of enemy action, is understood to be entirely separate from the rehabilitation training for re-entry into the Army.

News in English on Short Waves

THE following schedule of the transmission of news in English from the B.B.C. short-wave stations will be in operation when this issue is published. The times are BST (2 hours ahead of GMT).

0045: 31.32, 30.53, 25.53.
0300: 31.32, 30.53, 25.53.
0445: 49.10, 31.32, 30.53, 25.53.
0630: 49.10, 31.32, 25.53.
0815: 42.46, 31.75, 31.55, 31.25, 25.53, 19.82.
1000: 49.59, 48.43, 42.46, 41.49, 31.55, 30.96, 25.53, 25.29, 24.92, 19.82, 19.60, 19.51, 19.42, 16.84.
1300: 31.25, 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1500: 25.53, 19.82, 19.51, 16.84, 16.77, 16.64, 13.97.
1800: 42.11, 31.55, 25.53, 19.82, 19.66, 19.51, 16.84, 16.77.
2000: 31.55, 25.53, 19.82, 19.66, 16.84.
2245: 31.55, 31.25, 25.68, 25.53, 25.38, 19.82.
2315: 31.32, 31.25, 30.53, 25.53.
2400: 49.59, 48.43, 41.96, 41.49.

I.E.E. Wireless Section

A DISCUSSION on "Post War Planning in Radio Communication" will be opened by Sir A. Stanley Angwin and Mr. H. Bishop, chairman of the Wireless Section of the I.E.E., at the last meeting of the Section for the 1941-42 season, on May 6th, at 6 o'clock.

Listening by Order

A DECREE recently published in Germany orders that the personnel of public establishments must at once suspend all services to customers and remain silent during the transmission of German and Italian bulletins and special announcements.

Record Sales

IT is reported from America that in 1941 more than 110 million gramophone records were sold, and the final figure for sales of discs in this country during last year may also prove to be a record. To-day, however, in England the demand is greater than the supply, which has been curtailed by the scarcity of raw materials (shellac is imported mainly from India and Burma) and factory labour.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 5.0‡, 7.0.
WRCA (Bound Brook)	9.670	31.02	8.0 a.m., 10.45 a.m.
WRCA	15.150	19.80	4.0‡, 5.0‡, 7.0.
WGEO (Schenectady) .	9.530	31.48	10.45 a.m., 10.0†, 11.55§‡.
WGEA (Schenectady) .	15.330	19.57	3.15, 8.45§‡, 10.55§‡.
WBOS (Hull)	11.870	25.27	1.0 a.m.
WBOS	15.210	19.72	4.0‡, 5.0‡, 7.0.
WCAB (Philadelphia) .	6.060	49.50	7.0 a.m.
WCBX (Wayne) ..	11.830	25.36	12.30 a.m., 8.30‡, 9.15†, 9.45§‡.
WCBX	15.270	19.65	2.0, 6.0§‡, 8.30‡.
WRUL (Boston) ..	9.700	30.93	1.15 a.m.‡.
WRUL	11.730	25.58	1.15 a.m.‡.
WRUL	11.790	25.45	12.30 a.m.‡, 10.30‡.
WRUL	15.350	19.54	12.30 a.m.‡, 6.0*, 10.30‡.
WRUL	17.750	16.90	6.0*.
WLWO (Cincinnati) ..	15.250	19.67	7.0 a.m., 8.0 a.m., 7.0†, 8.0†.
China			
Chungking	5.950	50.42	4.0, 6.15.
	9.410	31.88	4.0.
	11.900	25.21	10.0 a.m., 10.30 a.m., 11.30 a.m., 12.15, 1.30, 2.0, 4.0, 6.0, 9.15.

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	9.45.
India			
VUD4 (Delhi)	9.590	31.28	10.0 a.m., 2.30, 5.50.
VUD3	11.830	25.36	2.30.
VUD3	15.290	19.62	10.0 a.m.
Sweden			
SBO (Motala)	6.065	49.46	11.20.
SBT	15.155	19.80	5.0.
Turkey			
TAP (Ankara) ..	9.465	31.70	9.15.
U.S.S.R.			
Moscow	6.977	43.00	1.0, 7.0, 9.0, 10.30, 11.45.
Vatican City			
HVJ	6.190	48.47	9.15.

MEDIUM-WAVE TRANSMISSIONS

	kc/s	Metres	
Ireland			
Radio Eireann	565	531	1.40‡, 6.45, 10.0.

It should be noted that the times are BST—**two hours** ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of the page.

* Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

Book Reviews

The Cathode Ray Tube and Its Applications (2nd Edition). By G. Parr. Pp. 176+XII; 80 figures. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 13s. 6d.

The book can be divided into four sections, dealing with the construction and principles of low and medium-voltage cathode-ray tubes, time-base circuits, applications of cathode-ray oscillography, and a bibliography of 737 items.

Since the whole of this is contained in a book of 176 pages, it is in the nature of an introduction to the subject, and serves as a key to the large amount of information on cathode-ray tubes and their associated circuits which is to be found in numerous published papers; it also serves as an outline handbook for those who use the cathode-ray oscillograph as a ready-made tool. A good feature is the inclusion of the less familiar circular and spiral time-bases, and the description of a number of applications which do not require any time-base. There is also a chapter on television, covering on the one hand scanning systems and synchronising circuits, and on the other the brightness modulation of the tube, including DC restoration. Typical of the thoroughness of the book is the inclusion with several of the circuit diagrams of complete tables of values of components.

It is stated in the preface that the revised edition had to be prepared in a limited time, and it must be admitted that one or two errors are to be found in it; however, even where they occur in circuit diagrams (e.g., the input to the two transformers in Fig. 47), they are obvious to the knowledgeable reader. D. A. B.

Thermionic Valve Circuits. By Emrys Williams, Ph.D., A.M.I.E.E. Pp. 174+VIII; 106 figures. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 12s. 6d.

The author is a lecturer at King's College, Newcastle-on-Tyne, and this book is based on lectures given to third-year degree students taking their B.Sc. in Electrical Engineering. The theory of the operation and design of thermionic valve circuits can be found in several comprehensive books covering the whole of radio engineering, but the author felt that there was a need for a small textbook dealing exclusively with this subject. At the present time there are a very great number of students in the colleges and technical schools studying this subject, and the moment is certainly opportune for bringing out such a book. Although the author assumes the reader to have a knowledge of mathematics and AC theory, he devotes the first chapter to a summary of the necessary AC theory. Chapter II deals with the valve itself and its characteristics, III and IV with amplifiers, V with Regeneration and Oscillation, VI with Detectors and Rectifiers, and VII with Frequency Changers and Modulators. The description is always clear, and graphical methods are used wherever they are applicable to the determination of the performance of the various classes of apparatus. It is unfortunate that the author uses the word "impedance" throughout the book for what is more correctly described as the AC resistance of a valve. Some people use "slope" or "differential" resistance, either of which is quite correct and expressive, whereas "impedance" should not be applied to something which has no connection with inductance or capacitance or frequency, but is based entirely on curves obtained with direct current and voltage. The author seems very undecided whether to call the grid voltage Vg or V1; it is first one and then the other, and sometimes the text has Vg whereas the Figure to which reference is being made has V1; however, one soon becomes accustomed to it.

G. W. O. H.

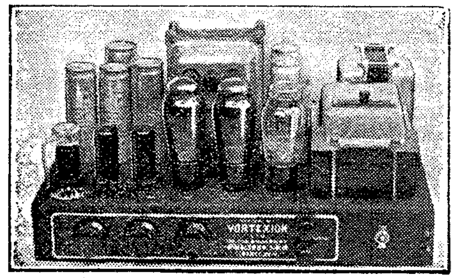
Books Received

Radio Handbook Supplement.—This book is intended to bridge the gap between the current edition of *The Amateur Radio Handbook* and a contemplated new edition, the preparation of which is not feasible in the present circumstances. There is a section dealing with fundamental principles which gives a complete "potted" course of radio, emphasis being laid on subjects having a special application to problems encountered by members of the Services. A section on radio mathematics is based on a series of articles which originally appeared in *The T. & R. Bulletin*, the official journal of the Radio Society of Great Britain. Cathode-ray oscillography, direction-finding and plotting are given considerable space in the book. The final chapter is devoted to data and formulæ. Pp. 160, with numerous diagrams. Published by the Incorporated Radio Society of Great Britain, 16, Ashridge Gardens, London, N.13. Price 2s. 6d.

Bristol Engineering Directory.—This book forms a complete directory to the engineering industry in the West of England, and is issued by the Bristol Engineering Manufacturers' Association, 104, Filton Ave., Bristol. Pp. 84. Price 9d.

VORTEXION

50w. AMPLIFIER CHASSIS



A pair of matched 6L6's with 10 per cent. negative feed-back is fitted in the output stage, and the separate HT supplies to the anode and screen have better than 4 per cent. regulation, while a separate rectifier provides bias.

The 6L6's are driven by a 6F6 triode connected through a driver transformer incorporating feed-back. This is preceded by a 6N7, electronic mixing for pick-up and microphone. The additional 6F5 operating as first stage on microphone only is suitable for any microphone. A tone control is fitted and the large eight-section output transformer is available in three types:—2-8-15-30 ohms; 4-15-30-60 ohms or 15-60-125-250 ohms. These output lines can be matched using all sections of windings and will deliver the full response (40-18,000 c/s) to the loud speakers with extremely low overall harmonic distortion.

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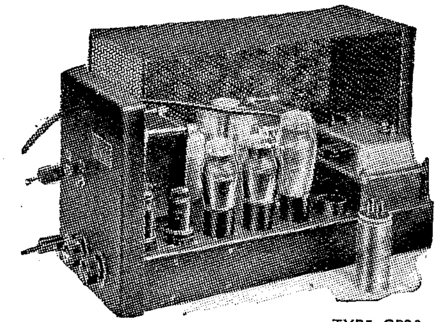
Moving Coil Microphones	£5 5 0
Chromium Microphone Stands from	£1 5 0

Many hundreds already in use

15w. AC & 12-VOLT DC AMPLIFIER



TYPE CP20

This small Portable Amplifier operating either from AC mains or 12-volt battery, was tested by the "WIRELESS WORLD," October 1st. 1937, and has proved so popular that at customers' demand it remains unaltered except that the output has been increased to 17.2 watts and the battery consumption lowered to 6 amperes. Read what the "Wireless World" said:—

"During tests an output of 14.7 watts was obtained without any trace of distortion so that the rating of 15 watts is quite justified. The measured response shows an upper limit of 18,000 c/s and a lower of 30 c/s. Its performance is exceptionally good. Another outstanding feature is its exceptionally low hum level when AC operated even without an earth connection. In order to obtain the maximum undistorted output an input to the microphone jack of 0.037 volt was required. The two independent volume controls enable one to adjust the gain of the amplifier for the same power output from both sources, as well as superimpose one on the other or fade out one and bring the other up to full volume. The secondary of the output transformer is tapped for loud speakers or fine impedances of 4, 7.5 and 15 ohms." **Prices**

AC and 12-volt CHASSIS with valves, etc.	£12 12 0
AC only CHASSIS with valves, etc.	£8 18 6

Gauze Case for either chassis, 12/6 extra.

Plus 25% War Increase on all above prices.

Orders can only be accepted against Government Contracts.

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RANDOM RADIATIONS *By* "DIALLIST"

Strange Phenomenon

TAKING a look at the sun the other day through the almost closed fingers of one hand, I was thrilled by seeing a gigantic spot near the middle of his disc. I'd wanted to see whether the great centre of disturbance that we saw in February had come round again into view. What I beheld was something even bigger and more clearly marked. And as I watched, my hair began to stand up on end, for before my eyes the spot started to move slowly and majestically from the centre of the disc towards the edge. For a moment I couldn't think what in the name of fortune was happening; there's nothing in the rules which allows for galloping sunspots! Then sanity returned, and glancing at the intervening window pane I observed a minute beetle thing making its slow progress across it. Curious that it should have chosen to take a brief rest at a point exactly between my eye and the sun when I took the first look.

Good Short Waves

If the February sunspots played havoc for a time with short-wave reception, there was ample compensation towards the end of March in the shape of a fine selection of SW stations coming in with splendid strength and very little fading. At my present Army station the only receiving apparatus available is an old "broadcast" receiver with one of those added-as-an-afterthought short-wave bands. The tuning is coarse, jumpy and about as bad in the way of backlash as any that I've handled. The valves are pretty dicky and the whole thing badly needs realigning. In other words, not a very good set! But with it I've been able in the evenings to pull in quite a bag of American and other short-wave transmissions. I only wish I had a communication receiver handy, for with good apparatus results must be wonderful. Perhaps readers who are still lucky enough to be handling Hammarlunds and Eddystones and Hallicrafters will say what kind of results they have had.

Your HTB Will Cost You More

IF you're a battery user, your HTB renewals are going to cost you more, for prices are now up by twenty per cent. However, it's an ill-wind that blows nobody any good, and the need to economise in this way may serve as a deterrent to those exasperating folk who switch their sets on when they get up and don't switch them off again till they go to bed. Indiscriminate users of mains sets may also be induced to cut down their listening to reasonable periods by the proposed rationing of domestic electric current. A smallish mains set used for twelve hours a day runs away with something like 60 units a quarter and few will have that much to play with. Reasonable listening for, say three or four hours daily, won't make a great hole in the rationed allowance of current. In fact, one can easily offset it by substituting a few 60-watt bulbs for 75's, 40's for 60's and 25's for 40's about the house in places where less brilliant illumination won't be noticed. What I did in my own home when I was last on leave may be found a useful tip. I rummaged out some of those double lamp-holders with a switch in one branch operated by pulling a string, and put them into bedroom and living-room fittings. Where there had been a 75-watt bulb I put in two 40's. If you don't want a bright light you use just one 40: if you want more you pull the string and use both. The combination of the two takes an extra five watts; but the single 40-watt bulb is so often sufficient that there is a real saving. Similarly, a 40 and a 25 were used to replace a 60-watt bulb and two 25's one of 40 watts. I reckon that the saving of current made in this way will be more than sufficient to supply all the household's needs in the matter of wireless programmes. One other tip: you can still get (at least I managed to the other day) 10-watt bulbs. These will often supply all the light that's absolutely necessary in passages and entrance halls, and the saving in price is considerable—besides simplifying black-out problems.

Golden Opportunity

WHAT an opportunity the war has provided for that standardisation of valve types which has for so long been a crying need. Wartime conditions have served to show us that we can carry on with comparatively few types. The number of different kinds of valves being manufactured is vastly smaller than it was in pre-war days; yet we manage to rub along not too badly. When the serviceman is called on to replace a dud of a type no longer obtainable, he uses his ingenuity and manages to make the set work with something different, making minor alterations in circuits or components if need be. This shows that we can afford to scrap a whole host of valves which, though they had been obsolescent for a long time before

BOOKS ON WIRELESS

issued in conjunction with "Wireless World"

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the autumn of 1939, were still to be found in makers' lists. During the war new sets have incorporated a comparatively small range of valves. The public, in a word, has got used to a reduced number of valve types and, though it may have groused a bit, it has not found that what almost amounts to standardisation has inflicted any very serious hardship.

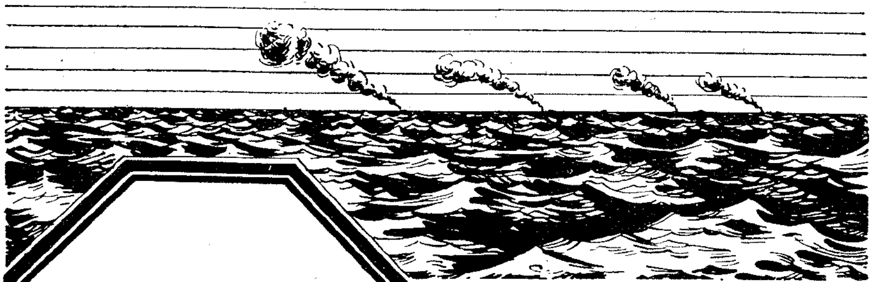
May It Be So!

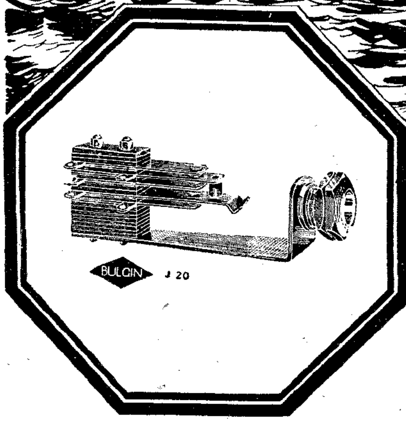
The iron being thus hot, the time to strike would seem to be when peace returns once more. If makers of valves will then ruthlessly prune their lists, cutting out all types except those that are genuinely needed, a big step forward will be made. There will be a still bigger one if they can get together and decide on a future co-operative programme. Such action would be greatly to the benefit of the man in the street, for concentration by the manufacturers on a limited number of types would undoubtedly mean lower production costs and therefore (let us hope!) lower prices. The public has for years been shy of any receiver containing more than four or five valves, because it has feared the possible cost of replacements, which might easily exceed the second-hand value of the set. Remove that fear, and the way is opened for a new era in wireless, the era of bigger and better sets. Well, here's hoping.

Accumulator Charging

NUMBERS of folk who have electric light in their homes use battery sets for one reason or another: a good many, I know, were installed early in the war by nervous people who got the idea that electric light supplies would be cut off when bombing started. Anyhow, the battery set, unless it's of the all-dry type, needs a filament accumulator, and what with (a) the calling-up of servicemen, (b) the restriction of collections and deliveries, and (c) the requests made in some districts to charging stations to reduce consumption, it's becoming increasingly hard to ensure that secondary cells are "refilled" when necessary. It's still possible to obtain trickle-chargers; some were advertised recently in *Wireless World*. Most of them deliver about half an ampere at a little over 2 volts. They are simple to use and cost very little to run. If there is electric light in the battery user's house, it may be well worth his while to invest in one of these devices. They don't cost much even in wartime, and they are so small that there's no trouble about finding a place for them.

COMMUNICATIONS DEPEND....





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Recent Inventions

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GRID-BIASING ARRANGEMENTS

THE use of a grid leak will automatically bias an oscillator or amplifier so long as grid-current flows, but should oscillations cease, or the grid drive fail in the case of an amplifier, the biasing voltage ceases and excessive space current may destroy the valve. Again, the method of deriving an automatic bias from a resistance in the anode-cathode circuit is subject to the limitation that the bias actually applied to the grid varies with the plate current.

In certain instances, as, for example, in Class B amplification, or in a telegraph transmitter, neither of these methods is satisfactory, because both the grid current and anode current are subject to considerable fluctuations

As an alternative, it is proposed to make use of the voltage drop across the anode and cathode of a mercury-vapour or similar gas-filled discharge tube, since this is practically independent of the current passing through it. A constant bias will therefore be maintained on the control grid of the main valve, irrespective of fluctuations in the output. The gas-filled tube is included in the anode-cathode circuit of the main valve in place of the ordinary ohmic resistance.

Amalgamated Wireless (Australasia), Ltd. Convention date (Australia), May 19th, 1939. *No.* 539603.

PIEZO-ELECTRIC COUPLINGS

TWO deep slots are cut out of the opposite sides of a slab of quartz, or other piezo-electric crystal, so as to leave two plates connected by an integral strip or bridge-piece. A pair of spring-pressed terminals make contact with metal coatings applied to the upper and lower surfaces of each of the plates. The crystal then acts as a selective filter, passing a frequency band which depends upon the length, width and thickness of the connecting strip.

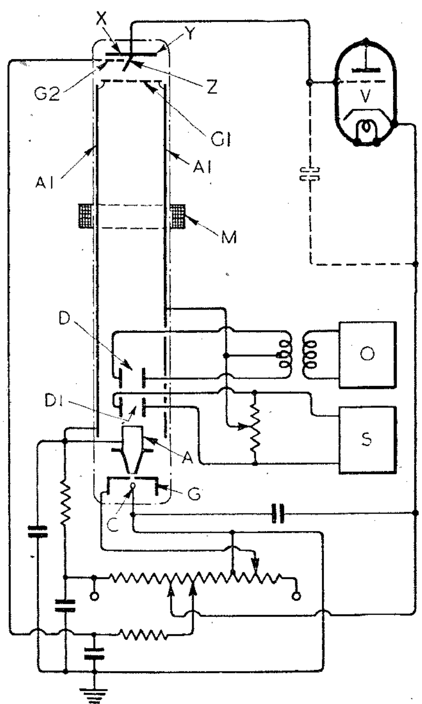
It is not necessary for both plates to have the same fundamental frequency of oscillation provided the dimensions of the bridge-piece are suitably chosen. The device gives a flat-topped response with a sharp cut-off at each end, even to a frequency band which is measured in cycles instead of kilocycles.

Standard Telephones and Cables, Ltd. (Assignees of W. B. Bohannon). Convention date (U.S.A.) June 8th, 1939. *No.* 540024.

CATHODE-RAY AMPLIFYING TUBE

THE figure shows a cathode-ray type of tube which is stated to be particularly suitable for use as an audio-frequency amplifier. Electrons from the cathode C are focused into a stream of elongated cross-section by a grid G, first anode A, second anode A1, and a magnetic coil M, on to a "divided" target X, Y, Z. High-frequency oscillations from a source O are applied to one pair of deflecting plates D, whilst the signals to be amplified are fed from S to a second pair of deflecting plates D1. The output from the target electrode is fed directly to the grid of a standard type of amplifier V which is coupled to a loudspeaker load.

The secondary emission target is in effect divided by a partition Z, across which the electron stream is swung to and fro by the deflecting voltages on the plates D. When the stream falls on the exposed surface of Y or Z, the secondary electrons are collected by an auxiliary grid G1 which shares the potential of the positive anode A1. The target electrode accordingly rises in potential.



CR tube arranged as AF oscillator.

When the electron stream passes on to the surface X, an auxiliary grid G2, at cathode potential, throws the secondary electrons back on to the target, which accordingly drops in potential. The resulting variations of charge are transferred to the grid of the valve V. Since the cathode-ray tube thus works into a pure capacity load, it is stated to be free from frequency distortion.

International Television Corporation, Ltd.; P. Nagy and M. J. Goddard. Application date, January 15th, 1940. *No.* 539661.

RADIATING A ROTATING FIELD

FOR ordinary short-wave signalling the aerial system is usually arranged to radiate energy which is predominantly polarised, either vertically or horizontally, according to the circumstances in view. In certain methods of direction finding or radio-navigational systems, it is, however, desirable to radiate a field in which the electric vector is made to rotate constantly.

Such a field can, for instance, be produced by arranging, say, three radiators at intervals of 120 deg. around a common support and coupling each of them to the supply line at points which are separated by an electrical distance of 120 deg., the progressive phase-displacement in the supply to each radiator then producing the required result; or four radiators may be arranged at 90 deg.

One of the difficulties in such a system is to prevent undesirable reflection effects, and an arrangement is shown in which this is overcome by coupling corresponding radiators in each stack or tier of dipoles to a common transmission line at points separated by an odd number of quarter wavelengths, so that the reflection effects mutually balance out.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of N. E. Lindenblad). Convention date (U.S.A.), May 20th, 1939. *No.* 539602.

STAND-BY "SELF-STARTER" RELAY

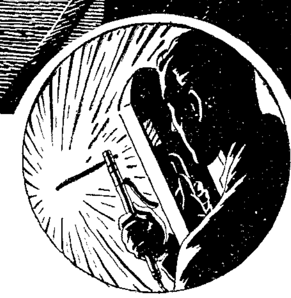
THE invention is concerned with a "watch-dog" relay, such as might be used for automatically switching-in a wireless receiver at the start of a programme from a given station. Since the relay must constantly be maintained in a receptive condition, the use of a valve would mean a considerable expenditure of current. At the same time, the device must respond to a weak signal.

The suggested arrangement includes a tuned input circuit coupled to the aerial and shunted by a crystal rectifier in series with a large condenser, preferably of the electrolytic type. An output circuit parallel with the condenser is normally kept "open," but is closed momentarily, every 15 seconds or so, by a clockwork or spring-operated contact. When signals of the required frequency are received, the condenser builds up a considerable voltage until such time as it can discharge through the clockwork-operated contacts. When this occurs the contacts are held closed by the signal.

Bush Radio, Ltd.; W. H. Harrison and H. L. Fletcher. Application date, May 15th, 1940. *No.* 540863.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2 price 1/- each.

When the iron is hot . . .



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Ode

Partridge

No. 15

ECONOMISE

When we think of cars so comfy
As we sit on saddles bumpy,
We sort of come down earthwards with a jerk.
But we can't restrain a chuckle
As our belts we tightly buckle,
And sally forth on cycles to our work.

Now it really does seem funny,
That altho' we've got the money,
We needs must trundle daily on two wheels.
Still, it's no use turning crusty,
Even if our cars get rusty,
'Cos we've *got* to get our foes down on their heels.

So pedal on and do your bit;
It'll help the lads and keep you fit.
Whilst, *pro tem.*, motoring joys are waived
Much "juice" and rubber will be saved.

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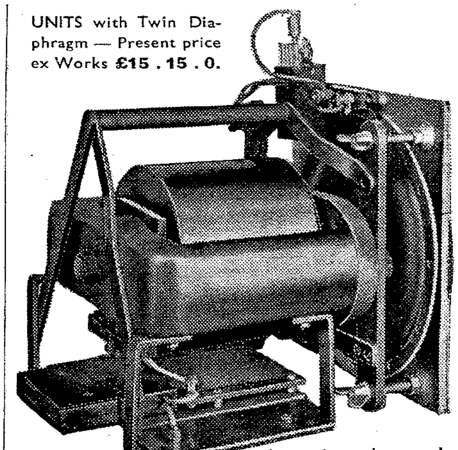

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TWO-GANG 0.00005mfd. Variable Condensers, ceramic insulation, small standard type, very efficient (no trimmers), new, boxed; 5/- each.

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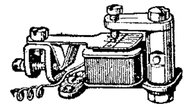

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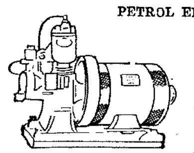

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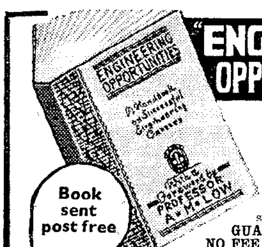

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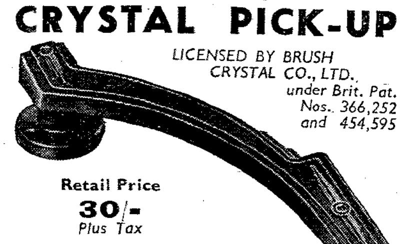

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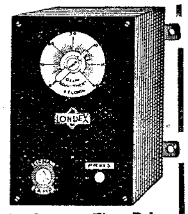

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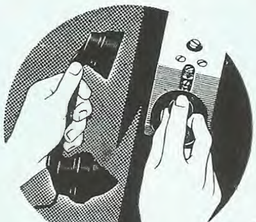

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